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MEMOIRS
OF THE
SAN DIEGO SOCIETY OF NATURAL HISTORY

Volume I

CATALOGUE OF THE MARINE

PLIOCENE AND PLEISTOCENE MOLLUSCA OF CALIFORNIA

AND ADJACENT REGIONS

With Notes on Their Morphology, Classification, and Nomenclature
and a Special Treatment of the *Pectinidae* and the *Turridae*
(Including a Few Miocene and Recent Species)

TOGETHER WITH

A SUMMARY OF THE STRATIGRAPHIC RELATIONS OF
THE FORMATIONS INVOLVED

BY
U. S. GRANT, IV
AND
HOYT RODNEY GALE

SAN DIEGO, CALIFORNIA
PRINTED FOR THE SOCIETY
November 3, 1931

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OF THE

SAN DIEGO SOCIETY OF NATURAL HISTORY

Volume I

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PRINTED AND BOUND
BY
SUNSET PRESS
SAN FRANCISCO, CALIF.

TO

MISS ELLEN BROWNING SCRIPPS,

PATRONESS OF SCIENCE AND EDUCATION,

WHO HAS MADE POSSIBLE

THIS PUBLICATION.

PREFACE

Preparation of the Material

The compilation of the data and the formulation of the opinions that comprise this volume were begun by the authors during the preparation of a joint dissertation to be submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Leland Stanford Junior University. The magnitude of the work, however, prevented its completion in the two years devoted to it before the authors received their degrees and necessitated more than a year of additional work to fill in partially the largest gaps. There is still much remaining to be done, and five or ten years more would be required to treat all the groups of mollusks with the same thoroughness that is now given some of the more important groups. Nevertheless, it is believed that the material already collected will be found of sufficient value to warrant publication at this time.

The original plan was to study and report on the paleontology and stratigraphy of the marine Pliocene and Pleistocene merely of the Ventura basin of southern California; but shortly after the field and laboratory work was begun, it became apparent that in order to arrive at a proper comprehension of the significance of the fauna in that region, it would be necessary to make a comparative study of many other Pacific coast species belonging to the genera represented. This necessitated a review of all the important literature on the Neocene paleontology of California and adjacent regions as well as most of the important papers on the local Recent mollusca. So much important and interesting information was thus accumulated that in order to make it readily available to future workers the scope of the paper was enlarged to include it.

Scope of the Work

This volume is divided into two parts. The first is a summary of the stratigraphic relations of the beds in which the fossils that are recorded in the second part were found, based not only upon an interpretation of the evidence offered by the fossils themselves but upon opinions derived from as many other different kinds of evidence as could be brought to bear upon the subject. In the second part an attempt is made to list every species and variety of marine mollusk known to occur in the Pliocene and Pleistocene deposits of California. In this part references are given to the original descriptions of species and varieties and to papers containing fossil records or other important information. The records of occurrence are outlined below the references, and in many cases the location of the type specimen and the type locality of the species are given. So far as time and space allowed, descriptions or brief diagnoses or comparisons have been added, as well as information about the genera and larger problems of classification. Often it has been necessary to revise the classification and nomenclature, and much more work in this direction is needed. Because of intimate relationships with the fossils of the California Pliocene and Pleistocene, most of the mollusks of similar age from Lower California, Mexico, and the region north of California to and including Alaska, and also some species from the Miocene and Recent faunas, have been added.

Division of the Work

The order of the names on the title page is not intended to indicate seniority of authorship.

The first or stratigraphic part was written by Mr. Gale and the ideas expressed in it were brought together entirely by him; but Mr. Gale wishes to acknowledge the advice and assistance in looking up certain points, especially in the San Diego region, given him by Mr. Grant and others. Considerably more than half of the second or systematic paleontology part, except the introduction, was written by Mr. Grant, with here and there a comment or the treatment of a single species by Mr. Gale. In most groups, however, revisions of the classifications or nomenclature were worked out by the writers together, as in the *Pholadidæ*, *Marginellidæ*, *Neptuneidæ*, *Pyrenidæ*, *Muricidæ*, *Cymatiidæ*, *Naticidæ*, etc. The changes in the classification of the *Arcidæ*, *Mactridæ*, and *Veneridæ*, and the specific rearrangements in those families and in the *Tellinidæ* and *Cancellariidæ* are in large part due to Mr. Gale; and certain groups, more particularly the *Pectinidæ*, the *Myacea*, *Siliqua*, the *Turridæ*, and *Ficus* were written by Mr. Gale and are almost wholly his work, though Mr. Grant contributed valuable assistance in procuring references and lending advice on the comparison of specimens and species.

The two authors co-operated in the compilation of the fossil and other records of all the species. Field work and collecting were done by Mr. Grant principally in the Pleistocene of the western end of the Ventura basin, but also a little near Goleta, Newport Beach, and San Diego; and by Mr. Gale principally in the Pliocene of the eastern or upper end of the Ventura basin. The latter author has also examined well cores from the southern part of the San Joaquin basin.

Acknowledgments

The writers are indebted to a number of persons and institutions for assistance in preparing this memoir. Under Professor Percy E. Raymond, of Harvard University, both writers received their introductions to paleontology, and a number of the ideas that they believe will prove most helpful in the future, especially to students of stratigraphy and paleontology, can be traced to their source in Professor Raymond. To the late Professor James Perrin Smith, of Stanford University, they are particularly indebted for suggesting the work, for watching its progress, and for giving from time to time when most needed that kind of enthusiastic encouragement that has been the inspiration of many of the best geologic and paleontologic productions in California and to which they would ascribe a large part of the credit for whatever may prove of value in this volume. Mrs. I. S. Oldroyd, Curator of the Collections of Recent Mollusca at Stanford University, has assisted in many ways, by explaining to the writers, especially when they were beginning their study, the forms and names of many Recent species and by pointing out many times the arrangement of the collections. Dr. Hubert G. Schenck, also of Stanford University, has always been ready to help in any way possible and has repeatedly called attention to important literature that might otherwise have been overlooked. Thanks are also due to Mr. A. M. Strong, conchologist of Balboa, California, for information and advice about some of the smaller gastropods; to Mr. George Willett, of the Los Angeles Museum, for information on some of the northern Recent mollusca; to Professor B. L. Clark, of the University of California, for the most cordial co-operation and liberal permission to examine any of the material in his charge; and to Mrs. Kate Stephens, Curator of Mollusks at the San Diego Society of Natural History, for information and the loan of specimens. Dr. W. P. Woodring, of the California Institute of Technology,

has also helped the writers, especially in matters of nomenclature. Dr. W. S. W. Kew and Dr. Frank Hudson, geologists of Los Angeles, have been very kind in criticizing the manuscript of the stratigraphic part of this memoir; and Mr. J. E. Eaton, also of Los Angeles, has aided by donating specimens and showing the writers collecting localities.

Of indispensable assistance was the large collection of Recent shells at Stanford University, to which the writers were allowed limited access. The paleontological collections at Stanford University, under the charge of Professor Smith, were available at any time and were also a valuable assistance. Other institutions have been most liberal in allowing the use of their materials. At the University of California, the writers were allowed access to all the collections and entrance to the library stacks, through the kindness of Professor Clark and the late Professor W. D. Matthew. At the California Academy of Sciences, Dr. B. W. Evermann, Director of the Museum, and Dr. G. D. Hanna and Dr. L. G. Hertlein, of the Department of Paleontology, gave the writers permission to study the collections and make use of the library. Mr. C. G. Abbott, Director of the Museum of the San Diego Society of Natural History, permitted the Society's library purchases for nearly two years to be guided by the library requirements of the writers, and for this very important help the writers are especially grateful. Dr. Alexander Wetmore, Assistant Secretary of the Smithsonian Institution in charge of the U. S. National Museum, Dr. R. S. Bassler, Curator of Geology in the U. S. National Museum, and Mr. W. C. Mansfield, Assistant Curator of Mollusks, have all been very obliging in furnishing information and photographs of specimens. Mr. E. G. Vanatta and Dr. H. E. Pilsbry, of the Academy of Natural Sciences of Philadelphia, have given similar assistance. The Widener Library at Harvard University has been very accommodating in supplying promptly photostats of rare publications. Sir J. R. LeB. Tomlin, of the British Museum, and Mr. Arthur E. Wrigley, English conchologist, have kindly given information difficult to procure in this country. For the privileges and help noted above, the writers wish to express their sincere thanks. To Dr. W. A. Bryan, Director, and Dr. J. E. Comstock, Associate Director, of the Los Angeles Museum, the authors are indebted for permission to use the collections and library under their charge in making late additions and corrections to the manuscript and galley proofs.

To Miss Ellen Browning Scripps, of La Jolla, California, the writers are much indebted for her generous aid, which has made possible the publication of this contribution without the substantial abridgement in size and in subject matter that would otherwise have been necessary. As one of the many benefits resulting from Miss Scripps' sincere interest in science and education, it has been possible to include discussions and explanatory matter which it is hoped will prove of value to university students and to those who are beginning their studies of California paleontology and stratigraphy. To Dr. Fred Baker, conchologist of Point Loma, California, and Vice-President of the San Diego Society of Natural History, the writers also wish to express their appreciation for aid in securing immediate publication of this report, as well as for helpful advice and the loan of material.

Both writers also wish to express their indebtedness to Mrs. Hoyt Rodney Gale for her valuable help in the tedious work of proof-reading and in preparing the index.

Purposes of the Work

Besides the merely mechanical compilation of information so that later students could have more ready access to the material available, the writers have attempted to broaden the outlook of the whole subject by introducing more information from distant or foreign sources, by noting occasionally the intimate relations between fossil and living mollusks of the Pacific coast of North America and fossil and living mollusks of other parts of the world, and by trying to substitute for the unfortunately too common and altogether unscientific guessing about the magnitude of the differences necessary to separate new species a greater consideration of mollusks, both fossil and living, as zoologic entities of necessarily variable characters. Coming from one part of the country to another, the writers had, perhaps, a special advantage and a special incentive in trying to avoid the evils of provincialism. The failure to go more than a short distance toward the aims just mentioned must be ascribed in large part to the writers' limited time, material, and experience but not in any significant degree to defects in the aims or principles worked upon. Such errors as have necessarily found a place in this report, and there are undoubtedly many, the writers desire to have corrected. It is hoped that at some later date it will be possible to publish a supplement with corrections and additions. In all respects the writers have tried to make this catalogue as useful as possible to all classes of students.

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PART I

SUMMARY OF THE STRATIGRAPHY

PART I

SUMMARY OF THE STRATIGRAPHY

Introduction

The following summary of the stratigraphic relations of the various formations from which fossils are reported in the systematic paleontology part of this memoir is offered here as an explanation and interpretation of the fossil occurrences. Original field work in preparation for this summary has been done only in some districts of southern California, so that part of the material presented here had to be based on a reinterpretation of the literature. As space does not allow a discussion of the details of the stratigraphy in the various regions dealt with, additional facts and complete proof of some of the generalizations here offered are to be sought in the literature referred to. The study of the molluscan record assisted by other available information has yielded some new points of view on the later Cenozoic history of California that are believed to be of considerable importance.

It is possible to recognize in California major marine cycles in the Miocene and Pliocene that can be correlated with the major marine cycles of Europe not only by means of fossils but also by means of the physical similarity of the cycles. California equivalents of the four European glacial ages and the corresponding interglacials can be pointed out and correlated on the basis of climatic changes. There is evidence to show that the later Cenozoic orogenic movements that produced the structures of the Coast Ranges were confined to a comparatively limited period of time, the beginning and end of which can be approximately dated; and the isostatic readjustment of the different crustal blocks can be recognized as caused by and subsequent to the orogenic movements.

The correlation of the Pleistocene glacial ages with those of Europe will afford an estimate in years, which, though very rough, will allow a crude quantitative estimate of the relative amount of work that the different geologic processes could have done during each of the various ages. For instance, it will give perspective to the current conceptions of the work of the ocean in cutting terraces during the later Pleistocene, and will emphasize the insignificance of the work done on the remnants of the terraces that are now exposed to view and the tremendous amount of work that must have been done on terraces that have been removed by later terrace cutting or have been hidden below sea level. Thus it will lead to a more precise visualization of the broad terrain of uplifted and depressed blocks that extended perhaps even to the edge of the continental shelf in fairly late Pleistocene time.

In the following treatment of the subject a few pages will be devoted to a discussion of the methods of correlation employed. Then a brief description of representative districts in California will be given, followed by a general summary of the correlations between districts with an outline of the later Cenozoic history of California. Finally will come a brief description of the European section and an explanation of the proposed correlations between California and Europe.

Methods of Correlation

Relation of Historic to Current Methods

The earliest correlations between geologic formations were made by tracing strata along their surface outcrops and noting the differences in lithology. Afterwards it was discovered that the fossils in some beds are different from those in others, and the fossils were used locally like the lithology to distinguish beds. These early methods were later expanded and applied to rock exposures that are not directly connected; and in the course of time similar sequences of lithologic units and similar sequences of fossil horizons came to be recognized as more reliable indications of correlation than similarities in single units. Furthermore, it was recognized that lithologic units may recur at various horizons but that faunal units usually do not, and the theory was formed that the differences in the latter were due to the extinction of old species and the evolutionary development of new. Other methods of correlation were added, particularly the use of unconformities and of the relative amounts of deformation and erosion.

These classic methods have been extremely useful, especially among the older formations of Europe and eastern North America where deposition was comparatively regular and comparatively slow, and where sufficient time elapsed between the deposition of successive formations for important evolutionary changes to take place. However, even in the older formations these methods have not always been sufficient, so that others have been sought; and in Cenozoic formations, especially in the later Tertiary and Quaternary of regions like California where violent deformation has taken place in almost modern times, deposition has been so rapid and irregular, and evolutionary changes have been so slight that other criteria are needed for a satisfactory working out of the geologic history. In the Pliocene and Pleistocene of California the lithology of the oldest beds may not differ materially from that of the youngest; and all the deposits but the very latest Pleistocene have shared equally in the only deformation that is clearly of widespread significance. The Pleistocene faunas contain practically no species of mollusks that have not left living descendants, and the Pliocene faunas contain only a few. As there are, however, even under such conditions certain very useful criteria for distinguishing the various horizons, it is worth while to consider to what extent the older conceptions can be applied and to what extent they have been altered or replaced by new.

First Appearance and Extinction of Species

Lyell's classification of the Cenozoic according to the number of living species in each division as compared with the number in that division that are now extinct is well known. The method of correlation upon which this classification was based can be used, however, only in a rough way and is useful only when the extent of the knowledge of the living fauna is taken into account and also the personal equation of the individual who has determined the species of the fossil fauna. The value of the method varies in the different parts of the geologic time scale to which it has been applied.

Of the Pleistocene species from San Pedro that were thought to be extinct, the majority have now been found living or have been identified with living species, especially those of the *Turridæ*, which once formed a considerable part of the supposedly extinct species. The cold-water horizons were thought to be older than they are now believed to be because the northern faunas were formerly not so well known. *Crepidula princeps* alone among the species represented in cold-water faunas is nominally extinct, being very closely related to its northern descendant, *C. grandis*. Of the other important

Pleistocene species supposed to be extinct, there remain only *Cantharus fortis* and *Cancellaria tritonidea;* and even these two species have living representatives in *Cantharus insignis* (Reeve) from Colombia and *Cancellaria cassidiformis* Sowerby from Panama. It may be only a question of time before living variations will be found that exactly match the fossil. Rarer species are still less to be relied upon in making correlations, because in many cases they are only peculiar forms of better known species, and because, even if they really are distinct, their significance cannot be determined on account of their rarity. Thus, for distinguishing the horizons of the Pleistocene from each other and from the Recent, if extinction of species alone were depended upon, only a few varieties and closely related forms of doubtful value could be used.

In the Pliocene, however, the approaching cold of the glacial epochs caused extensive migrations of faunas and the extinction even of some of the important species. *Pecten bellus* and *Pecten opuntia* are notable among the species that persisted into the cold-water zone that is here referred to the uppermost Pliocene, and then disappeared. In the middle Pliocene there are a number of warm-water species that are not known in later deposits. Among the most important are: *Arca trilineata, Mactra* (*Spisula*) *albaria, Mactra* (*Pseudocardium*) *densata, Mytilus coalingensis, Ostrea atwoodi, Pecten* (*Patinopecten*) *coosensis* variety *dilleri, Pecten* (*Patinopecten*) *healeyi, Pecten* (*Lyropecten*) *estrellanus* variety *cerrosensis, Venus* (*Chione*) *securis* variety *fernandoensis, Astræa* (*Pomaulax*) *gradata, Cantharus humerosus,* and *Turritella vanvlecki.* The varieties listed are believed to be the last representatives of older species. In addition, the species known living only in Japan should be added: *Pecten* (*Pallium*) *swiftii* and varieties, and *Cancellaria hemphilli* (= ? *thomasiana* Crosse). In the lower Pliocene there are but a few more to increase the number of important Pliocene species that have become extinct: *Arca terminumbonis, Pecten purisimaënsis* (another variety of *coosensis* ?), *Ficus* (*Trophosycon*) *ocoyana* varieties, *Thais imperialis,* and the species probably still living in Japan, *Psephæa oregonensis* (= ? *prevostiana* Crosse). The *Ficus* is found in the lower Pliocene of various localities and also at the base of the San Diego section where it might be assigned tentatively to the middle Pliocene. Thus, it is seen that the most important break, the only horizon where the extinction of species is of any considerable help, comes at the first appearance of cold temperatures toward the end of the Pliocene epoch.

The number of extinct species in the Pliocene is already known to be much less than half of the total so far recorded from the Pliocene; and as the living faunas of western Mexico and Central America, where many of the middle and lower Pliocene species are now living, are still imperfectly known, it is to be expected that even more of the supposedly extinct species will be found alive. In the Miocene a much larger proportion of the species are extinct; but survivors of species formerly supposed to be extinct keep turning up in southern waters, usually of course in the eastern Pacific but sometimes in the Orient and sometimes even in the Atlantic, so that it is somewhat doubtful whether as many as half of the species are extinct. *Pecten crassicardo,* for instance, appears to be living in the Galapagos Islands as *P. magnificus;* and the Oligocene *Nucula gettysburgensis* apparently is living in Japan as *N. mirabilis* Adams and in India as *N. fultoni* Smith.

Climatic Changes

In the late Tertiary and even more in the Pleistocene, climatic changes have provided a means of correlation that is superior to that afforded by the extinction of species. At times, of course, the two go together, as when toward the end of the Pliocene the lowering of the temperatures was the principal cause of the extinction of species. Carpenter, Dall, Smith, Arnold,[1] and others have long recognized the presence of rather marked climatic changes as an important characteristic of the later Tertiary and the Quaternary of California, and the importance of these changes is to be emphasized here even more than has usually been done. The correlation of the various formations deposited along the Pacific coast of the United States from the Miocene to the Recent has been made possible perhaps as much by climatic changes as by the extinction of species.

Sometimes paleontologists have made use of the differences in the thermal facies of faunas without realizing what they were doing. To the older writers who had little opportunity to know the faunas living northward and southward from the boundaries of the United States and to modern workers who do not believe that specimens coming from widely separated localities can belong to the same species, a fossil fauna representing a climatic extreme has the appearance of containing more extinct species than it really does and hence of being older than it really is. Only so long as the older formations were deposited under more extreme climates than the younger has this lack of knowledge or the equivalent erroneous assumption led to the correct conclusions. It seems to have made little difference for comparative purposes in California whether the species of the warm-water Miocene and lower Pliocene are extinct or have merely migrated to southern waters; but in later times when the climate fluctuated from warmer than at present to colder, and then warmer again, and must have passed several times through stages when the conditions were approximately the same as at present, it is to be expected that the faunas of such times would be more like the faunas now living off the coast in the same latitudes than were the faunas that lived during some of the intervening or succeeding intervals. Here may lie the explanation of why there was thought to be a greater number of extinct species in the upper than in the lower Pleistocene of San Pedro. Furthermore, in correlating deposits of different latitudes the climatic factor must be taken into account; and it must be recognized that during times when the average temperatures were gradually falling, the faunas of northern latitudes may resemble in some respects the later faunas of lower latitudes. It may be for this reason that the Empire formation of Oregon and its equivalent, the Montesano formation of Washington, were assigned by Howe[2] to the Pliocene, whereas they have generally been considered upper Miocene and are tentatively considered upper Miocene in this paper. Similarly, when the effects of the shifting of climatic zones up and down the coast are taken into account, it is easier to understand how such a form as *Pecten caurinus* can be a useful guide fossil in the uppermost Pliocene of southern California although it is still living in the Northwest and may even extend back to the Miocene in that region. In other words, climatic changes are a fundamental cause of the differences in faunas and should be taken into account along with the extinction of species.

Not only are the changes in past climates useful in making more detailed local correlations, but there is reason to believe that they have been very widespread in their effects so that they may be used as accurate guides for making correlations with distant regions. They provide in the later Tertiary and Quaternary the best criteria yet found for establishing exact time equivalence. This subject will be discussed later in connection with the proposed correlations between the California and European sections.

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[1] Arnold, R.: "Environment of the Tertiary Faunas of the Pacific Coast of the United States," Journal of Geology, Vol. 17, pp. 509-533, 1909.

Smith, J. P.: "Climatic Relations of the Tertiary and Quaternary Faunas of the California Region," Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, pp. 123-173, 1919.

[2] Howe, H. V.: "Faunal and Stratigraphic Relationships of the Empire Formation, Coos Bay, Oregon," Univ. Calif. Publ. Geol., Vol. 14, pp. 85-114, 1922.

Sedimentary Cycles

Another means of dividing geologic deposits into natural units and of aiding in the correlation of formations, a means too often overlooked or disregarded, is provided by the physical relations of the beds themselves. In order to have a marine deposit laid down in a region that previously has been subjected to erosion or to continental deposition, it is necessary for marine waters to transgress over the land; and during this process they often leave easily recognizable littoral deposits or basal conglomerates at the contact with the underlying formation. Also, if we are to see the deposit at all, it is necessary for the sea to have withdrawn at some time from the area, leaving behind it another zone of littoral deposits which may or may not have been preserved. Such a series of events is known as a sedimentary cycle. If the transgression and regression are extensive enough it is known as a major cycle, but if not, as a minor cycle or oscillation of the shore line.

In California there appears to have been one well-marked major cycle in the Miocene and another in the Pliocene, and so far as can be determined the beginnings and endings of these cycles are coincident with the beginnings and endings of the time divisions in the European section. Just why the relations of land and sea should be the same in such widely separated regions it is impossible to state, for too little is known about the physical forces of the interior of the earth. It is not impossible that the land remained relatively stable in the two regions and that the sea level varied (eustatically) according to the elevation or depression of the ocean bottom in other parts of the world, that the relative elevation of the oceans and continents is dependent upon some still unknown igneous cycle. On the other hand, the accumulation of horizontal pressures in the earth's crust may have been transmitted throughout wide, perhaps even world wide, areas, affecting the weaker portions of the crust in remote parts of the earth in varying amounts but at essentially the same time. In spite of statements to the contrary, it seems probable that California as well as northwestern Europe remained relatively stable during the Miocene and during the Pliocene and that the only widespread deformation in California that would upset the orderly sequence of sedimentary cycles did not come until the middle of the Pleistocene.[1] Of course locally the relations are complicated by minor earth movements and toward the edges of basins by minor oscillations of the shore lines, but if viewed comprehensively the sequence seems to be remarkably simple. Even if the similarity between the California and the European sections is nothing more than a coincidence, as long as the paleontologic and climatic evidence seems to support the essential contemporaneity of the major divisions of the two, it is desirable for practical purposes to consider them the same.

The subject of sedimentary cycles is briefly explained and illustrated in a little book by Stamp.[2] Of California authors, apparently the only one who has expressly considered this subject is Dr. Louderback of the University of California. His paper on the Miocene cycle[3] may not have all the details explained correctly and everyone may not agree with the nomenclature used, but the general principles involved and the general history of events are described more clearly in this paper than they are in other California publications.

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[1] The post-Miocene deformation seems to have been chiefly a gentle warping of the land surface, only locally severe, and it seems to have come at a time when the Miocene cycle was naturally drawing to a close through the filling up of the basins of deposition. The California Pleistocene deformation may have been accompanied by contemporaneous movements in the Alps and in other parts of the world, and may be of more than local significance. The California Upper Miocene deformation may even be a reflection of the Alpine revolution.

[2] Stamp, L. D.: "An Introduction to Stratigraphy (British Isles)," London, 1923, especially pp. 12-19, 266-310.

[3] Louderback, G. D.: "The Monterey Series in California," Univ. Calif. Publ. Geol., Vol. 7, pp. 177-241, 1913, especially pp. 232-241.

Effects of the Profile of Equilibrium on Sedimentation and Correlation

The profile of equilibrium is the submarine surface above which sediment cannot rest without being again disturbed by wave action, unless the prevailing conditions are changed. If the waves are cutting a plane of marine denudation along the shore line, they cut down to the profile of equilibrium. If material is being deposited, it is deposited up to the profile of equilibrium. When an area of deposition is filled up to the profile of equilibrium, deposition ceases in that locality and the material is carried farther out to deeper water. Thus there are gaps in the sedimentary record, gaps that represent a time when the area was still under water and are quite different from unconformities or disconformities as usually understood. These gaps, known as *diastems*, may represent whole geologic periods, lasting as long as the relations of land and sea are constant.

Deposition usually takes place from the shore outward, with a small original dip seaward. If the sea level is lowered, the profile is lowered and the upper (shoreward) ends of the beds are truncated. If the sea level rises again, the beds of the new series will rest, perhaps with slight angular unconformity, on the oldest as well as on the youngest beds of the older series. Even a big storm causes a temporary lowering of the profile of equilibrium, with the accompanying scour and later refill. Thus it is easy to see how minor changes in conditions complicate the sequences in marine near-shore deposits, causing mixtures of material of different ages and accounting for the anomalies in such occurrences as the Pleistocene beds at San Pedro, where the details (though not the major events) of warm and cool water faunas seem to be almost hopelessly jumbled and indicate events that probably have little geologic significance. This aspect of sedimentation has been considered in a recent article by Eaton;[1] but as a rule it has been almost entirely ignored, strange to say, in California where it is most important. The San Pedro irregularities were described in a recent paper by Crickmay, which is discussed later.

Correlation of Marine Terraces

The marine terraces exposed along the coast of California appear to be of two kinds.

One kind of terrace is formed after a comparatively rapid rising or sinking of the land in respect to sea level. A rapid depression of the land causes the waves to attack the slopes of the drowned terrestrial surfaces, slopes which are usually steeper than the normal slope of the submarine profile of equilibrium. A rapid elevation of the land causes the waves to attack the also comparatively steep slope at the outer end of the profile of equilibrium. In either case, the waves work on the edge of a body of water that is abnormally deep near the shore; and as a result, deposition begins at the initial shore line, working outward, and the cutting action of the waves is mainly horizontal. Such a process produces a bench many miles or only a few hundred feet in width according to the length of time the land and sea maintain the same relative position. The inner edge of the bench becomes a steep cliff. Such is the nature of the present shore line of California, due in most cases to a comparatively recent sinking of the land.

The other kind of terrace is formed only during a period of prolonged but very gradual uplift by a slight acceleration in the rate of uplift. If the ocean has developed a very long and very gently sloping profile of equilibrium so that the water remains shallow far from land, then a very gradual uplift of the land causes the wave action to expend its energy in lowering the bottom, and the ocean can no longer cut back the shore line. The ocean may even lose ground and be forced to withdraw its shore line gradually, leaving behind littoral deposits. In that case a slight increase in the rate of uplift causes a more rapid retreat of the shore line and produces a terrace with more gentle slope merging with the steeper slope above. Perhaps a later return to the more gradual rate of uplift may cause the slope to become steeper again at the outer edge of the terrace, and the changes in slope may continue indefinitely with the formation of numerous terraces separated by steeper slopes. The steepest slopes represent the times of most gradual marine retreat. Such is the explanation of the terraces forming the Burton Mesa of the Santa Maria district and the lower terraces at San Diego. In each case, where preserved, a thin conglomeratic sandstone covers the tops of the terraces and the slopes between them with a continuous blanket of littoral deposits left behind by the retreating sea. Of course, if the uplift become still more rapid, the shore line may retreat at once to the outer end of the old profile of equilibrium, and then the waves can begin to cut back horizontally the other kind of terrace, with a steep cliff at the back on which are no marine deposits.

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[1] Eaton, J. E.: "The By-Passing and Discontinuous Deposition of Sedimentary Materials," Bull. Amer. Assn. Pet. Geol., Vol. 13, pp. 713-761, 1929.

The two kinds of marine terraces are, however, not so fundamentally different as might at first appear. The difference is partly in the emphasis laid in the first case on the cutting of the terrace and in the second on the marine withdrawal from the terrace. At times of marine retreat, the rapid withdrawal of the water in the first case corresponds to the acceleration of the rate of withdrawal in the second, producing the comparatively flat surface of the terrace; and the still-stand of the first, producing a sea cliff without deposit, corresponds to the slower movement of the second, producing a steeper, deposit-covered slope. The distinction is valuable because it provides criteria for estimating the rate of marine withdrawal and for estimating the width and dip of the submarine slope. Also, the first kind of terrace may indicate continental sinking or the rise of sea level.

In discussions of the ages of terraces, marine or terrestrial, it is sometimes important to make clear whether it is the time of the original cutting of a bench, or of the deposition of material on the bench or older surface, or of the withdrawal of the depositing or cutting agent (i. e., the age of the flat surface of the terrace), or of the cutting into the terrace by the beginning of a new cycle of erosion that is referred to as the age of the terrace. In physiographic discussions of peneplain remnants or of river terraces, it is usually the last that is meant; in physiographic discussions of marine terraces it may be the first; and in discussions of deposits it is usually the second or third, which, if the deposit is thin, may be approximately the same. River terraces should be discussed as carefully as marine, for broad old valleys indicate still-stand of base level, deposition of terrace materials indicates depression, and cutting into older valleys or deposits indicates uplift.

At present, correlations between individual terraces can be made only at short distances. It is clear that readjusting movements were differential in California for a time at least after the mid-Pleistocene deformation, and may even be slightly diverse in different districts today. However, if it be recognized that after most of the local readjustment had been accomplished the major stages in the uplift and later depression of the coast were widespread and essentially contemporaneous, it may in the future be possible to make more distant correlations between such terraces perhaps as the San Diego Mesa and the Burton Mesa, or between some of the river terraces of southern California.

Conclusion of Remarks on Correlation

From the foregoing discussion, it will appear that correlation in the late Tertiary and Quaternary between California formations that are in separate basins or are separated in such a way that they cannot be traced or identified by lithology or other direct means, and correlation between these formations and formations in other parts of the world, can be done in some cases by noting the presence of the important living and extinct species in each formation or the important species that the formations have in common; but in other cases the climatic method may be more useful or more accurate; and sometimes the position of the formations in the marine sedimentary cycle seems to be an assistance. The sedimentary record may be complicated somewhat, especially in detail, by submarine diastems, scour, and fill under the control of the profile of equilibrium. At present, correlation of terraces must be done very cautiously.

Description of Local Sections

The Ventura Basin

The later Cenozoic marine sequence of the Ventura basin, when studied in connection with the lower Pleistocene sequence of the Los Angeles basin, provides a key for the unraveling of the later Cenozoic history of California, and for this reason will be discussed somewhat in detail. The Ventura basin contains one of the most interesting, probably the thickest and most complete of the sections of later Tertiary and Quaternary deposits in California. The maximum thicknesses of strata in the Pliocene and Pleistocene approach 16,000 feet and 4,000 feet respectively on the north side of the basin between Santa Paula and Ventura. The principal publications[1] on the region have been by Eldridge and Arnold, English, Kew, Eaton, Cartright, Waterfall, and Pressler; and another by P. Kerr and H. G. Schenck is in the course of publication.

The Ventura basin is a structural syncline or synclinorium heading in an area about 30 miles north-northwest of Los Angeles in the upper end of the Santa Clara Valley of the South and extending in a westerly direction for a distance of about 45 miles to the city of Ventura on the coast, where the widening V of the basin plunges beneath the water. The coast line westward from Ventura to and beyond Santa Barbara, 50 miles or more, may be the extension of the extreme northern rim of the basin. The Channel Islands, lying off the coast to the southward, may or may not be remnants of the submerged southern rim. The edges of the basin to the north and to the south are, in general features, anticlinal; but in some cases they are faulted up or overthrust over the basin.

Granites and very old metamorphic rocks in this region are generally classed together by geologists as the basement complex. The basement complex is overlain by a thick section of Cretaceous and Eocene sediments, mostly marine, followed by non-marine Oligocene beds and the younger marine sequence that will now be described. As geol-

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[1] Eldridge, G. H., and Arnold, R.: "The Santa Clara Valley, Puente Hills, and Los Angeles Oil Districts of Southern California," Bull. 309, U. S. Geol. Survey, pp. 1-36, 1907.

English, W. A.: "The Fernando Group Near Newhall, California," Univ. Calif. Publ. Geol., Vol. 8, pp. 203-218, 1914.

Kew, W. S. W.: "Geology and Oil Resources of a Part of Los Angeles and Ventura Counties, California," Bull. 753, U. S. Geol. Survey, pp. 1-107, 1924.

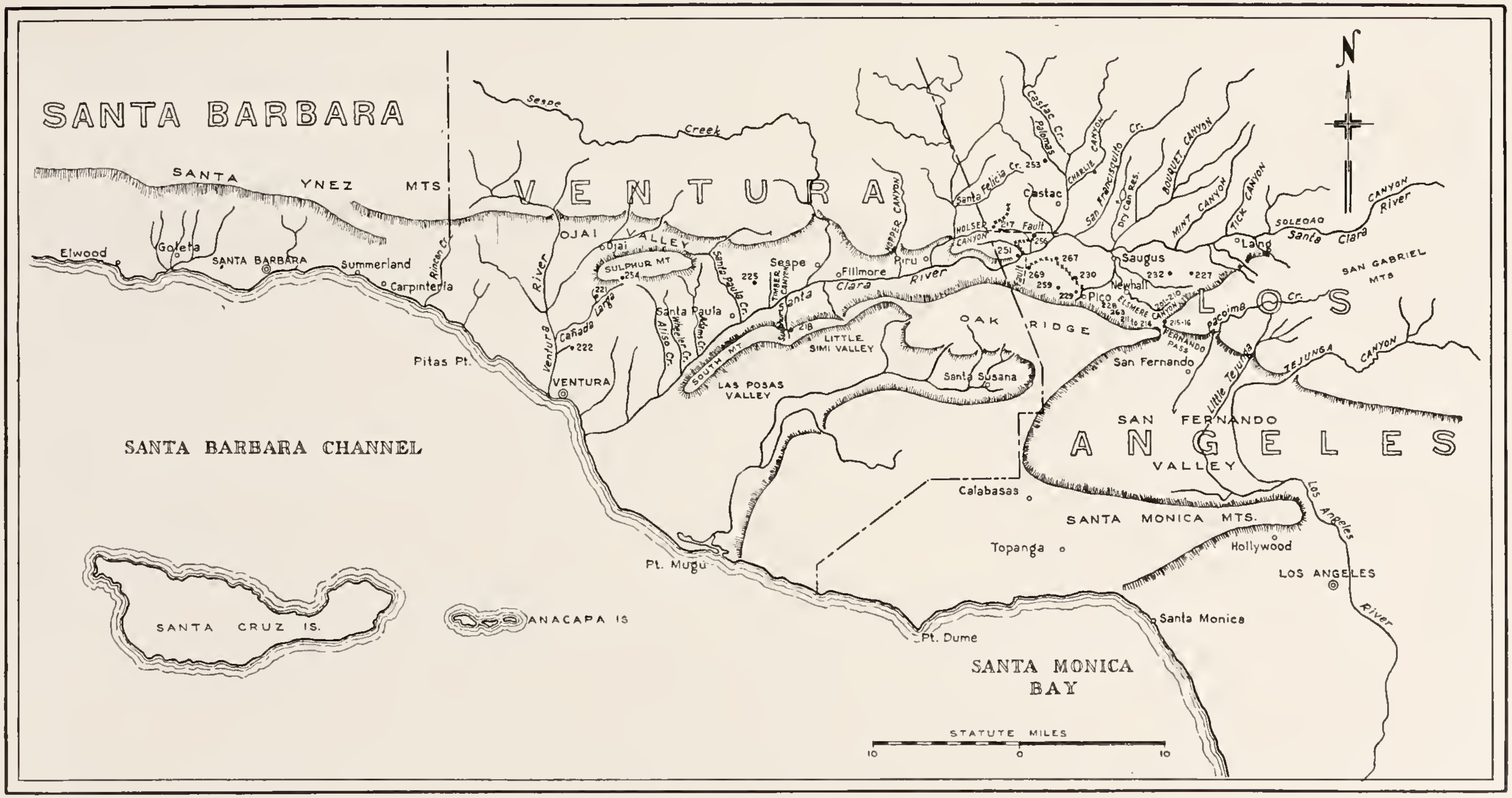
Eaton, J. E.: "Divisions and Duration of the Pleistocene in Southern California," Bull. Amer. Assn. Pet. Geol., Vol. 12, pp. 111-141, 1928.

Cartright, L. D., Jr.: "Sedimentation of the Pico Formation in the Ventura Quadrangle, California," Bull. Amer. Assn. Pet. Geol., Vol. 12, pp. 235-269, 1928.

Waterfall, L. N.: "Contributions to the Paleontology of the Fernando Group, Ventura County, California," Univ. Calif. Publ. Geol., Vol. 18, pp. 71-92, 1929.

Pressler, E. D.: "Fernando Group in the Las Posas-South Mountain District, Ventura County, California," Univ. Calif. Publ. Geol., Vol. 18, pp. 325-345, 1929.

DIAGRAM A


SANTA BARBARA
SANTA YNEZ MTS
Elwood
Goleta
SANTA BARBARA
Summerland
Carpinteria
Rincon Cr.
Pitas Pt.
SANTA BARBARA CHANNEL
SANTA CRUZ IS.
ANACAPA IS
VENTURA
Sespe Creek
OJAI VALLEY
Ojai
SULPHUR MT
254
221
Cañada Larga
222
Ventura River
VENTURA
Santa Paula
Santa Paula Cr.
Aliso Cr.
Wheeler Cr.
Adams Cr.
225
Sespe
TIMBER CANYON
Sulphur
Santa Clara River
218
SOUTH MT
LAS POSAS VALLEY
LITTLE SIMI VALLEY
Fillmore
Piru
HOPPER CANYON
Santa Felicia Cr. 253
Castac Cr.
Palomas
CHARLIE CANYON
Castac
HOLSER CANYON
217
Fault
256
251
267
269
230
259
229
Pico
San Francisquito Cr.
Dry Can Res.
BOUQUET CANYON
MINT CANYON
TICK CANYON
Saugus
232
227
Newhall
228
263
211 to 214
ELSMERE CANYON
201-210
215-16
FERNANDO PASS
OAK RIDGE
Santa Susana
SOLEDAD CANYON
Santa Clara River
Lang
SAN GABRIEL MTS
LOS ANGELES
Pacoima Cr.
TEJUNGA CANYON
Little Tejunga
San Fernando
SAN FERNANDO VALLEY
Calabasas
SANTA MONICA MTS.
Hollywood
Topanga
LOS ANGELES
Los Angeles River
Santa Monica
Pt. Mugu
Pt. Dume
SANTA MONICA BAY
STATUTE MILES
10
0
10
N

Sketch Map Showing the Ventura Basin

Some of the fossiliferous outcrops are marked by locality numbers or small crosses.

ogists are still not in entire agreement concerning the location of the Miocene-Pliocene boundary, a brief account of the Miocene deposits is inserted here to show what, according to the views expressed in the present paper, preceded and formed the setting for Pliocene deposition.

The Miocene marine cycle in the Ventura basin began with the encroachment of the sea over the nearly flat surface of the alluvial outwash deposits of the Sespe formation (Oligocene and partly lower Miocene), which at that time probably resembled very closely the alluvial outwash deposits that are now forming on the nearly flat floor of the San Joaquin basin. The Vaqueros formation, which was then deposited in the western part of the Ventura basin, grades upward from a sandy basal phase representing the littoral zone of marine transgression, first into a buff-colored clay shale and then with practically imperceptible change into the hard black shales interbedded with yellowish calcareous strata that lie at the bottom of the Monterey formation. In the middle Miocene, represented by the Monterey formation, the sea had encroached still farther on the land, depositing sediments in the eastern part of the basin as well as in the western. In the western part, then relatively far from shore, the black shales were followed by typical, whitish, thinly-laminated siliceous shales, which are hard and opalized below, but sometimes light and porous above, often sulphurous and petroliferous. Eastward, however, more sandy material is intermixed with the shales, and the shore phase is again to be found, especially to the southeast. The Santa Margarita formation,[1] upper Miocene, is known from undoubted fossil evidence only in the northeastern corner of the basin where it was mapped as "Modelo (?)" by Kew. There it consists of soft, fine and coarse, buff-colored sandstones with interbedded conglomerate lenses; and the oyster-facies fauna that it contains in places suggests that the basin was filling up and giving place near its head to brackish-water or mud-flat conditions. Elsewhere this stage of deposition may be represented by the upper part of the Monterey formation as described above; or it may never have been deposited; or it may have been removed by erosion following the diastrophic readjustment that brought the Miocene cycle to a close. The last phase of a marine cycle is always the least likely to be preserved.

A large part of the sequence just described is known locally as the Modelo formation, a formation which appears to include at its type locality north of Fillmore all of the Miocene except the Vaqueros, possibly including even some of the Vaqueros. There seems to be evidence at this locality of at least three minor marine cycles or oscillations. The Vaqueros basal phase exposed in Sespe Creek grades up into a shale which is followed by a return of near-shore conditions indicated by a sandstone series, above which lie a middle shale, an upper sandstone, and an upper shale. In the upper sandstone were found poorly preserved fossils believed to be upper Miocene in age, and because of them and similar forms found in the Santa Monica Mountains the whole of the Modelo has been assigned to the upper Miocene. It seems more probable, however, that the lower sandstone and middle shale represent the Monterey minor cycle, and that only the upper cycle should be assigned to the upper Miocene or Santa Margarita formation. The lowest shale contains fossils like those of the Temblor formation, middle Miocene, and should therefore be called Temblor or upper Vaqueros. The striking similarity of the whole sequence of lithologic and faunal units found in several regions from the western part of the Ventura basin northward to the southwestern side of the Salinas Valley, middle California, where the Vaqueros and Monterey formations were originally described and not far from the locality at which the Santa Margarita was first described, shows that conditions were more than local and that the older well-known formational names can be applied with perfect propriety in the Ventura basin. As the name Modelo does not apply to a natural unit and is not needed, it should be abandoned.

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[1] The term Santa Margarita formation is here used in a general sense, as the name that was earliest applied to the upper Miocene part of the section. San Pablo and other later names are reserved for use when more detailed subdivisions such as have been made in middle California can be recognized.

In the Ventura basin, as well as in other parts of California and possibly also in Oregon and Washington, the upper Miocene minor cycle of sedimentation is more distinct than the other minor Miocene cycles, for it seems to have been preceded by diastrophic readjustments causing it to overlap locally on non-marine or pre-Miocene formations. In the northeastern corner of the Ventura basin it overlaps on a non-marine wedge of the Mint Canyon formation. As vertebrates in the Mint Canyon formation indicate that the Mint Canyon is upper Miocene in age[1], the overlying Santa Margarita of this region must be very high in the Miocene, and the next series of beds younger than the Santa Margarita is almost necessarily Pliocene. Hudson and Craig[2] found the upper division of the Modelo locally unconformable over the middle division, which is here believed to be the Monterey part of the Modelo.

Overlying what appears to be typical siliceous Monterey shale in various parts of the basin where the Santa Margarita formation is not definitely recognized is a brown shale series of somewhat uncertain relationships. In places it seems to have a fossiliferous basal phase, for very recently a sandy and conglomeratic stratum carrying an abundant molluscan fauna has been discovered. The new locality lies on the slopes above Pico Canyon, stratigraphically far below the Miocene-Pliocene contact as mapped by Kew, and yet it is said that the fossils are of Pliocene age, presumably like those at the well-known Elsmere Canyon locality not far away. Unfortunately, an opportunity to examine this material has not occurred and no opinion can be given of its significance. It may be well to mention, however, that it is very difficult to distinguish the normal shore fauna of the upper Miocene from that of the lower Pliocene, many of the species being distinguished nomenclatorily but not morphologically. Elsewhere this formation of disputed age can be seen to grade upward from the siliceous shales, changing in character by the admixture of more and more detrital material until in the upper part it consists principally of a brittle silty shale. This shale was originally gray but is now stained chocolate-brown along many fine lines of shelly cleavage, so that only the centers of the largest flakes remain gray. Interbedded with this chocolate-brown shale are thin, hard, medium-grained sandstone strata and a few conspicuous but lenticular beds of conglomerate. From the stratigraphic evidence it is strongly suggested that this formation represents the end of the Miocene sedimentary cycle and is the equivalent of the Santa Margarita formation already definitely identified in the basin; but at present, the general trend of opinion favors including it in the lower Pliocene, and it is possible that the Pliocene beds of Elsmere Canyon are a continuation of its basal phase as noted near Pico Canyon.

At or near the beginning of the undoubted Pliocene a change of conditions took place. Either the relief of the surrounding territory was accentuated by somewhat more pronounced warping, or it may be merely that a rising of sea level inaugurated the new sedimentary cycle and caused the full-sized waves of the overdeepened basin to attack the gneissic and granitic hills of the San Gabriel Range and the other older formations around the edges of the basin, bringing about the deposition here and there of unusually persistent, heavy conglomerate and coarse yellowish sandstone lenses. Interstratified with the conglomerates and sandstones is a greater volume of buff sandy shale, perhaps the material of the upper Miocene reworked, the buff sandy shale with occasional soft gray or yellowish sandstone lenses grading upward into gray clay shale. The typical gray shale of the Pliocene can be distinguished from the chocolate-brown shale by its softer, more clay-like character, and by the presence in many places of pebble-like, orange, limonitic nodules, often weathered out into rectangular fragments.

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[1] A very recent summary of the vertebrate fauna of the Mint Canyon formation by John H. Maxon has appeared in Publication No. 404 of the Carnegie Institution of Washington, pp. 77-112, 1930.

[2] See Hudson, F. S., and Craig, E. K.: "Geologic Age of the Modelo Formation, California," Bull. Amer. Assn. Pet. Geol., Vol. 13, pp. 509-518, 1929.

Fossils appear to be abundant only along the old shore line around the northwestern end of the San Gabriel Range, being best exposed in Elsmere Canyon and east of Fernando Pass. These fossils include a few species that are more characteristic of the Miocene than of the Pliocene, such as *Pecten estrellanus* (typical variety ?) and the variety *catalinæ* but not variety *cerrosensis*, and *Ficus* (*Trophosycon*) *ocoyana* varieties, as well as the echinoid genus *Astrodapsis*, represented by *A. fernandoensis* Pack. For this reason, they have sometimes been assigned to the Miocene. Similar assemblages with an admixture of Miocene species have been found in other California localities where the basal phase of the Pliocene is fossiliferous, and these other occurrences have likewise been assigned to the Miocene, especially the Jacalitos fauna, lower Pliocene of the San Joaquin basin, which contains in common with the Elsmere Canyon fauna the species noted above and also *Pecten healeyi* variety *lohri*, *Venus* (*Chione*) *elsmerensis* (a close relative or variety of *V. gnidia*), *V.* (*Chione*) *securis* variety *fernandoensis*, *Forreria magister*, *Cancellaria tritonidea* var. *fernandoensis*, and *Clavus* (*Clathrodrillia*) *coalingensis* (+ *elsmerensis*), besides numerous non-diagnostic species. Because of the similarity in fauna and stratigraphic position, the correlation between the Jacalitos and the Elsmere Canyon beds is considered well established.

In spite of the few more characteristically Miocene species that lived on for a short time into this horizon, the faunal relations are much closer with the overlying middle Pliocene than with the Miocene, the middle Pliocene being distinguished only by the absence of the *Astrodapsis*, of the *Ficus*, of *Venus* (*Chione*) *elsmerensis*, *Arca terminumbonis*, and *Forreria magister*, by the different varieties of *P. estrellanus* and *P. healeyi*, by the appearance of a few species not known in lower horizons such as *Arca multicostata* variety *camuloensis*, *Pecten bellus* varieties, *Astræa gradata*, and the brachiopod *Terebratalia* (or *Dallinella*) *occidentalis*, and by the abundance of *Pecten purpuratus* varieties, *Pecten deserti* varieties, and *Ostrea vespertina*. Other fossils poorly preserved but probably belonging to the basal phase of the Pliocene in the Ventura basin are found at locality 227 S. D. S. N. H., south of Humphreys Station in the upper end of the Santa Clara Valley, including among other species *Ficus ocoyana* variety and *Pecten healeyi* variety *lohri*. They overlie the Mint Canyon formation.

At locality 259 S. D. S. N. H. on the slope of hill 2010[1] west of Pico Canyon and at locality 229 somewhat nearer Pico Canyon, and also at locality 254 east of the big bend in Sulphur Canyon south of Sulphur Mt., are more, poorly preserved fossils of doubtful significance which are here referred to the basal Pliocene. They occur in locally cemented hard calcareous sandstones and concretions. If the newly discovered locality near Pico Canyon really belongs to the basal Pliocene, then this last series of localities belongs to a fourth zone between the zone here assigned to the middle Pliocene and the zone called basal Pliocene. In that case locality 253 west of Palomas Canyon may represent this horizon also; otherwise it probably belongs to the middle Pliocene zone.

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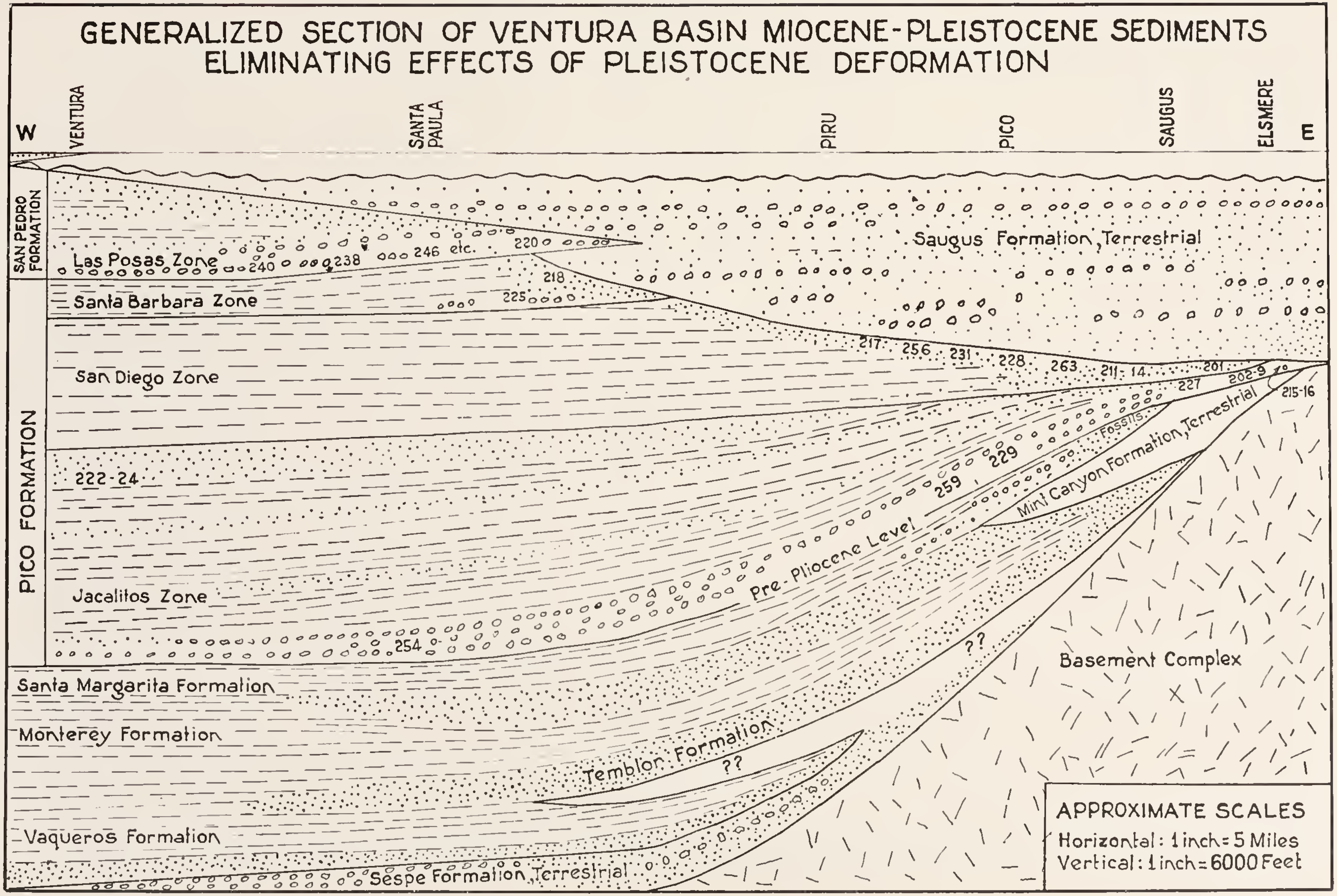
[1] So marked on the U. S. Geol. Survey topographic sheet. For the localities mentioned, see the accompanying sketch map or the description of localities in part 2.

DIAGRAM B



GENERALIZED SECTION OF VENTURA BASIN MIOCENE-PLEISTOCENE SEDIMENTS ELIMINATING EFFECTS OF PLEISTOCENE DEFORMATION

W
VENTURA
SANTA PAULA
PIRU
PICO
SAUGUS
ELSMERE
E
SAN PEDRO FORMATION
Las Posas Zone
240
238
246 etc.
220
218
225
Saugus Formation, Terrestrial
Santa Barbara Zone
217
256
231
228
263
211-14
201
202-9
227
215-16
PICO FORMATION
San Diego Zone
Fossils
Terrestrial
Mint Canyon Formation, Terrestrial
229
259
222-24
Pre-Pliocene Level
Jacalitos Zone
254
??
Basement Complex
Santa Margarita Formation
Monterey Formation
Temblor Formation
??
Vaqueros Formation
Sespe Formation, Terrestrial
APPROXIMATE SCALES
Horizontal: 1 inch = 5 Miles
Vertical: 1 inch = 6000 Feet

Kew has proposed the name Pico formation for the Pliocene beds exposed in Pico Canyon, expressly including the Elsmere Canyon horizon and also the uppermost fossiliferous horizon at Pico Canyon which is here considered middle Pliocene in age. Thus the Pico at its type locality originally included the lower and middle Pliocene zones. In the western part of the basin similar beds extend upward without marked lithologic break into the upper Pliocene, and there the name Pico has been applied to the whole sequence. Some writers believe that a formation name should cover only the horizons represented at the type locality and that it should not be extended to the whole of the natural unit to which it belongs, even when the unit is later found to be more completely represented elsewhere. It seems more logical and more practical, however, to take the view that a formation name should apply to the whole of the unit, else there would be an unnatural fragment left over that would be hard to deal with; just as in vertebrate paleontology, if someone should describe and name the leg of a rabbit, it is universally agreed that the name shall apply to the whole of the rabbit. Thus the term Pico formation is here used to include all the marine beds in the Ventura basin that are now considered Pliocene in age. Several well-marked zones are recognizable in the Pico: at the bottom, the Jacalitos zone; in the middle, the San Diego zone; and at the top, the Santa Barbara zone. In some places these faunal zones are recognizable as lithologic units also, and it might be thought desirable to apply to them their respective names as formation names. If so, it seems much better to use the older names of the standard section, since the correlations have already been made beyond reasonable doubt, than to learn a new set of local names. The term Pico cannot be applied to any one of the zones by itself, for at its type locality it includes at least two of them, and if later another zone is recognized between the Jacalitos and the San Diego, it will include three. Also, it is antedated by all the other names. If the various members of the Pico are given formation names, then the Pico, including them all, should be used as a group name. The old group name Fernando is no longer of use, for it covers the whole of the Pliocene marine cycle and the lower Pleistocene marine cycle as well, and has no unity at all.

Eaton, in an obscure paper,[1] has proposed the name Santa Paula formation for the lower part of the Pliocene section exposed in Adams Canyon and vicinity north of the Santa Clara River. This name would probably apply also to the lower Pliocene or Jacalitos zone of Elsmere Canyon; but it is probably unnecessary, for the correlation of the beds at the latter locality with the Jacalitos formation of the San Joaquin basin appears to be sufficiently certain to make the name Jacalitos available, if needed.

Mr. Eaton, in a recent interview, expressed the opinion based on foraminiferal evidence and detailed field mapping in the Ventura basin and on the literature of other places in California that there is a widespread unconformity of importance between the lower Pliocene and later Pliocene deposits of California, accounting for the absence around the edges of the basins of part of the section represented in the centers of the basins. The evidence for this opinion has not appeared in the study of the molluscan remains. Although it is not unlikely that there may have been differential movements shifting the areas of deposition and possibly bringing higher relief on the land and the deposition of coarser sediments for a time, the evidence seems unsatisfactory that there was any great marine retreat at the time. A temporary halt in the depression of the basin would cause transportation of material across the profile of equilibrium and account for the absence of part of the section nearer the shore.

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[1] Eaton, J. E.: "Ventura Field Controlled Reservoir," Oil and Gas Journal, Vol. 25, No. 25, p. 72, November 11, 1926.

Immediately above the lower Pliocene zone already described, the conglomerates and sandstones disappear, except in a very few places where lenticular masses mark the course of what appear to be old delta channelways. The gray clay shale is so homogeneous in character that in most places it reveals nothing of the structure. In the western part of the basin the section is very thick, continuing with much the same character into the upper Pliocene, the very top of which, the littoral phase, seems to have been removed in most places by the advance of the Pleistocene sea. In the eastern part of the basin the shale in turn grades upward into more and more sandy strata with the return of shore-line conditions, and more persistent sandstones and conglomerates reappear. Near this upper part of the section fossils become very abundant, forming an almost continuous and easily recognizable zone all the way from Fernando Pass to Holser Canyon. It is possible that this zone may be divided into three subzones as follows: (1) shaly facies, at the top of the shale section; (2) normal sandy facies with a typical shore-line fauna, usually overlying the shaly facies; and (3) oyster-bed facies, representing the last stage of marine deposition. The faunas of these three facies must have lived contemporaneously, and hence represent conditions of deposition which in most cases happen to occur in the same succession but cannot be used to distinguish fine divisions in a time scale. The whole zone probably passes upward into successively higher and higher horizons with the gradual retreat of shore-line conditions westward.

The most easterly occurrence of the middle Pliocene faunal zone may be at locality 201 S. D. S. N. H. in the upper horizon at Elsmere Canyon. Here the section is very thin, probably near the apex of the marine Pliocene wedge, and the upper and lower littoral zones are separated by only 200 or 300 feet of oil-stained shaly sandstone. The strike in the upper part of Elsmere Canyon appears to be rather regular, about N. 45° E., the beds sloping away from the granite with a dip of 35° or less northwestward. The figures given by English in the publication referred to above are probably misprints or apply to some other part of the region. The fauna at locality 201 is poorly preserved and fragmentary; but it contains several fragments of *Pecten estrellanus* variety *cerrosensis*, and as its stratigraphic position corresponds to that of other occurrences of the middle Pliocene fossiliferous horizon, it is here assigned tentatively to the upper littoral zone. A small *Ficus* also occurs at this locality; but it is not well enough preserved to show whether it is a typical *Ficus*, or a *Trophosycon* that had survived a short time after the sea had begun to retreat, living on there into the middle Pliocene as other individuals of the same species did at San Diego. It is of course possible that this upper horizon in Elsmere Canyon is just another fossiliferous lens of the better known fossil zone found below, and may not have the significance here attached to it. In that case it would probably be necessary to assume that the upper littoral zone had been washed away before the deposition of the thin layer of overlying alluvial gravels of the Saugus formation.

The upper littoral zone is easily recognized on the two flanks of the syncline that forms the ridge over the railroad tunnel south of Newhall. From there it can be traced almost without break westward to Pico Canyon, where it is the upper of the two fossiliferous Pliocene horizons noted by Kew, and thence along the northeast rim of the flat-bottomed valley (Potrero Valley) northwest of Pico Canyon. It swings around the northwest end of the flat-bottomed valley, where it is cut off by a N.-S. normal fault. It can be picked up again in San Martinez Grande Canyon on the north side of the Santa Clara Valley. On the east side of this canyon there is a fossiliferous outcrop that may belong to a slightly higher horizon, probably not more than 100 feet higher, in which the oyster-bed facies is well developed, as it is also in some localities at a similar horizon south of the Santa Clara Valley. The oyster-bed facies outcrops along the bluff east of the canyon as far as the big bend in the canyon where it passes under a shallow syncline and strikes eastward on the southern dip slopes of some of the highest hills, finally ending in the little double anticline of hill 1668 on the U. S. G. S. topographic sheets, east of San Martinez Chiquito Canyon where it is cut off by an E.-W. thrust fault. The normal facies appears again north of the fault on hill 2223 at the head of Holser Canyon, from whence it swings around northward to the top of hill 2018 and eventually crosses the Hasley Canyon road just east of the divide. By walking along the outcrops of the fossiliferous strata and by noting other parallel lithologic units it is possible to demonstrate to a reasonable degree of certainty that all of these localities belong to a single zone of littoral deposits. All the overlying strata are non-marine sands and gravels belonging to the Saugus formation; all below belong to the marine Pliocene.

Some of the marine fossil localities in the littoral zone just described have been mapped as Saugus, and some as Pico (middle and lower Pliocene). It is probably in part because of the assignment of some of these occurrences to the Saugus that the name Saugus has been applied, as is now believed erroneously, to marine beds of various ages. From being applied to the middle Pliocene marine beds just described the name was again shifted to the Pleistocene deposits in the western part of the Ventura basin. If the present correlations are correct it is quite obvious that the name Saugus should be used only for non-marine beds such as occur in the vicinity of the town of Saugus, that the Saugus may include the entire non-marine equivalent of the Pliocene marine sedimentary cycle and also part of the Pleistocene, but that the name is in no way applicable to the Pleistocene marine beds of Ventura County.

The fauna of the shaly facies of the middle Pliocene is usually rather poor, containing only casts of small pelecypods. The normal sandy facies is characterized by *Pecten* (*Pallium*) *swiftii* and varieties, *Pecten* (*Aequipecten*) *deserti* and varieties, *Pecten* (*Janira*) *bellus* and varieties, *Ostrea vespertina*, *Turritella vanvlecki*, *Dosinia jacalitosana*, *Pecten* (*Aequipecten*) *purpuratus* and varieties, *Pecten* (*Lyropecten*) *estrellanus* variety *cerrosensis*, *Pecten* (*Patinopecten*) *healeyi* typical variety, *Pecten* (*Janira*) *stearnsii* and varieties, *Arca multicostata* variety *camuloensis*, *Arca trilineata* variety *calcarea*, *Venus* (*Chione*) *securis* variety *fernandoensis*, *Cantharus fortis* varieties but probably not the typical, *Astræa* (*Pomaulax*) *gradata*, *Fusinus barbarensis* and varieties, *Cantharus humerosus*, *Cancellaria hemphilli*, and others. The first four, including *Pecten bellus* variety *coalingaënsis* and in addition many non-diagnostic species, are found also in the "*Pecten coalingensis* zone" of the San Joaquin basin; and as the two zones correspond in stratigraphic position, it seems quite certain that they can be correlated closely enough for practical purposes. Furthermore, nearly all of the species just listed, including *Dosinia jacalitosana* (a close relative of *D. ponderosa*), are found in the type section of the San Diego formation. As there can be little question of the correlation of the San Diego formation with this middle Pliocene zone of the Ventura basin, it is hereby proposed to call it the San Diego zone of the Pico formation.

The oyster-bed facies is characteristic of the last marine deposits in a rapidly filling shallow embayment. It is found not far above the normal sandy facies on both sides of the Santa Clara Valley. Its fauna consists usually of a few species that are very common, with here and there a straggler from the normal sandy facies. The common species are *Dendraster diegoensis* Kew, variety ?, a variety resembling very closely in its size and shape and in the arrangement of the petals *D. oregonensis* (W. B. Clark in Dall) but with the anus in the normal position; *Pecten* (*Janira*) *bellus*, especially the distorted variety *slevini*; and *Ostrea vespertina*, usually the underdeveloped variety *sequens*. The fauna of this facies, including the few normal species such as *Cantharus humerosus* that straggle into it, does not in any way indicate that there is any material difference in age between this facies, which is merely an environmental facies, and the normal. None of the cold-water species of the upper Pliocene is found in it.

As the shore-line moved gradually westward, the littoral zone rose to higher and higher horizons (i. e., higher horizons in a time scale, though if the depositional process involved merely a filling up of the basin, taking place progressively from the shore outward, the later deposits may have been laid down all at the same absolute altitude); and somewhere in the region where the records have been removed by erosion there must have been a transition between the middle and upper Pliocene. In the Ventura and Santa Paula quadrangles, the Pliocene molluscan faunas are very poorly represented. The littoral zone probably had risen into the upper Pliocene before it reached this part of the basin, and much of it may have been removed by the readvance of the sea in the lower Pleistocene. Localities 222 to 224 S. D. S. N. H. are fossiliferous lenses deposited in the midst of the tremendously thick section of the Ventura and Santa Paula quadrangles, but their fauna is not sufficiently characteristic to make their assignment to the middle Pliocene certain. Probably the locality referred by Waterfall to the "lower Pico" represents this zone.

The upper Pliocene is a comparatively cold-water zone containing numerous specimens of species that live today between Alaska and Puget Sound. A characteristic and varied fauna is found at locality 218 S. D. S. N. H. in Sulphur Canyon east of South Mt. (not to be confused with the Sulphur Canyon south of Sulphur Mt.). Here are found in abundance *Pecten* (*Patinopecten*) *caurinus*, *Pecten islandicus* and the varieties *hindsii* and *jordani*, *Pecten beringianus*, *Natica* (*Tectonatica*) *clausa*, *Neptunea andersoni* variety *hawleyi* (a close relative of *Neptunea lirata*), *Neptunea venturaënsis*, and a number of species that occur in cold water but also range southward, such as *Pecten hastatus*, *Fusinus barbarensis*, and *Spirotropis* (*Antiplanes*) *perversa* with varieties both dextral and sinistral. This fauna has been described by Waterfall as the upper Pico. On the north side of the Santa Clara Valley this same zone forms a continuous strip at the top of the homogeneous gray clay shale just below the Pleistocene contact, and may be traced from the eastern edge of the Santa Paula quadrangle many miles to the westward. It may be recognized there by the abundant specimens, mostly fragmentary, of *Pecten caurinus*, which weather out all over the hillsides and are very noticeable. It contains, however, practically no other recognizable species. Locality 225 S. D. S. N. H. between Timber Canyon and Santa Paula Creek is somewhat below the main part of this zone, in a sandstone and conglomerate lens, and has a more varied fauna, though *Pecten caurinus* is practically the only diagnostic species.

The upper Pliocene has been called by various names, middle or upper Fernando, upper Pico, Santa Barbara horizon, Ventura horizon (in part), etc. In spite of reports to the contrary, the upper Pliocene is not represented by marine beds in Pico Canyon or Fernando Pass; but as explained above, it seems reasonable to extend the term Pico as a formational or group name to include this zone as upper Pico. The name Santa Barbara with its type locality at Packard's Hill, Santa Barbara, is the earliest name applied to this restricted zone. Packard's Hill and its fauna were described by Arnold in his San Pedro Memoir,[1] and the Santa Barbara horizon was recognized by Smith.[2]

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[1] Arnold, Ralph: "Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, California," Mem. Calif. Acad. Sci., Vol. 3, 1903, especially pp. 50-53.

[2] Smith, J. P.: "Climatic Relations of the Tertiary and Quaternary Faunas of the California Region," Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, pp. 123-173, 1919, especially pp. 141, 149, 150, 151.

Arnold described and listed a fauna from another Santa Barbara locality, which he called Bath-house Beach, thinking at the time that it represented a higher horizon; but later, as pointed out by Waterfall, he listed from the Bath-house Beach locality the four diagnostic species by which he had previously distinguished the Packard's Hill locality, and it is almost certain that the two localities represent the same horizon. The name Ventura horizon proposed by Carson[1] might also be applicable; but the localities cited by Carson and the small fauna listed represent a mixture of Pliocene and Pleistocene, and the name is not needed. This cold-water upper Pliocene faunal zone will here be referred to as the Santa Barbara zone. Pressler has shown that in the Las Posas region south of South Mountain minor diastrophic readjustments caused the Santa Barbara sea to transgress over folded Oligocene and Miocene formations leaving a thin deposit that now underlies the better represented succeeding zone. The movement was apparently not great.

The marine beds in the western part of the Ventura basin formerly called "Saugus" overlie the Santa Barbara zone. There is seldom, if ever, an angular unconformity between the two; but the overlying beds are coarser grained and north of the Santa Clara Valley have at the base a very persistent zone of littoral fossils, giving good evidence that they were deposited by a later marine transgression. They contain a fauna practically identical with that of the Pleistocene at San Pedro, in which nearly all of the species are still living. These beds have long been thought to be of Pliocene age because they were involved in the great diastrophic revolution that was formerly said to come at the end of the Pliocene. However, because of the Recent aspect of the fauna, because of the correlation with the San Pedro Pleistocene beds, because of the stratigraphic position above the Santa Barbara zone, which is, as explained later, correlated with the uppermost Pliocene of Europe, and because vertebrate and physiographic evidence in various parts of southwestern United States have shown that the diastrophic revolution took place well along in the Pleistocene, these beds are now considered to be of Pleistocene age. Similar beds in the Los Angeles basin embrace a series of zones, and the same may be true of the Ventura basin. The lowest and most extensive zone of both basins was recently named in the Ventura basin the Las Posas formation by Pressler.[2] It contains a warm-water fauna, and, as explained later, corresponds to warm-water beds that underlie the equivalent of what Arnold called Pliocene at Deadman Island in the San Pedro region of the Los Angeles basin. Higher horizons have been recognized near the city of Ventura, and future work may enable paleontologists to differentiate higher zones corresponding to the cold-water "Pliocene" of Deadman Island and to the cool and possibly also warm water horizons equivalent in the San Pedro region to what Arnold called the lower San Pedro series. It is not to be supposed that the *minor* changes in these faunas giving some an aspect slightly more characteristic of cool waters and others an aspect slightly more characteristic of warm waters can be traced for any great distances, for the changes are probably due to local shifting of currents and local changing of depths; but the general similarity of conditions in the Ventura basin to those at San Pedro, where the major changes of temperature are unquestionably of importance, is apparent.

It has already been pointed out above that inasmuch as the name Saugus was originally applied near the town of Saugus to non-marine deposits that range from the middle or older Pliocene through the Pleistocene, it should not be applied to the marine

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[1] Carson, C. M.: "Pliocene Faunal Zones in Southern California," Pan-American Geologist, Vol. 43, pp. 269, 270, 1925.

[2] *Op. cit.*

Pleistocene in the western part of the Ventura basin, the two occurrences being of different origin and in large part of different age. The name Ventura horizon given by Carson is vaguely defined, without definite type locality, and its mixed fauna and original correlation below the Santa Barbara zone rule it out of consideration here. It seems desirable to have a single name for the series of marine strata overlying the Santa Barbara zone, and the term lower San Pedro series proposed by Arnold, although the lower part of the section was not originally included, seems to be the most appropriate. Tieje, after Kew, proposed to alter "lower San Pedro series" to "San Pedro formation," excluding the upper Pleistocene Palos Verdes (formerly called upper San Pedro series), which was deposited after the great Pleistocene diastrophic revolution. This course seems justifiable, for the beds above the Santa Barbara zone that are involved in the diastrophic revolution form a natural unit, a sedimentary cycle like the Pliocene sedimentary cycle. In the San Pedro formation (or group), then, can be recognized the lower warm-water or Las Posas zone, the middle cold-water Deadman Island "Pliocene," which might be called the Timms Point zone since Deadman Island no longer exists, and the upper zone of cool and possibly also warm-water horizons which is the typical San Pedro zone. Eaton has given the name Hall Canyon formation to what he believed to be the uppermost member of the sequence in the Ventura basin; but in his description he apparently included some of the reddish upper Pleistocene non-marine terrace or fanglomerate formation, which is much better exposed on the hills west of Timber Canyon where it overlies unconformably the Pliocene-Pleistocene marine series. Dr. Schenck has visited the locality and states that it is not quite certain to which formation the beds photographed by Eaton belong.

After the deposition of the San Pedro formation or group (the lower San Pedro series) there occurred what appears to be the greatest diastrophic revolution that affected the region since the close of the Jurassic. All of the formations were involved in the folding, and in some places even lower Pleistocene strata were tilted at high angles or overturned. Faulting accompanied the folding, especially thrust faulting during the orogenic disturbances. The major compressive movements seem to have been confined to a comparatively limited period, general opinions to the contrary notwithstanding, and movements since that time have been mostly of the nature of readjustments, possibly isostatic, involving differential elevations or depressions along normal faults and broad regional warpings, but seldom important folding or thrusting.

Erosion acted upon the deformed beds during and after the time of the deformation, reducing all but the older hard formations to a surface of moderate relief. This old surface is marked by high-level terraces and deposits of older alluvium or fanglomerate that were formed at the bases of the upthrust mountains. One of the best of these remnants is a deposit of reddish fanglomerate occurring on the tops of the ridges and bevelling the edges of the upturned marine beds west of Timber Canyon on the north side of the Santa Clara Valley. This deposit was formed at the base of Santa Paula Peak, a mountain composed of abnormally hard Eocene strata with a present altitude of almost 5000 feet, that was folded and upthrust during the mid-Pleistocene diastrophism. As the fanglomerate surface passes undisturbed across the trace of the fault, it is evident that the movement along the fault had ceased before the deposition of the fanglomerate. A similar relationship has been reported along the southwestern side of the northwestern end of the San Gabriel Mountains, showing that the great pair of San Gabriel faults also became extinct before the deposition of the older terraces. Other remnants, probably of this same old surface, in the upper end of the Santa Clara Valley, that were mentioned by Lawson[1] and are now clearly to be seen from the Ridge Route highway north of Saugus, do not seem to have been disturbed by the continuations of the San Gabriel and other faults that pass among them. On the eastern end of South Mountain across the Santa Clara Valley and across the Santa Clara Valley fault from Timber Canyon are also remnants of an old surface with a slope that suggests that it was once the opposite slope of the valley at the time of the deposition of the Timber Canyon fanglomerate, no movement having taken place along the intervening fault since then. The tops of the ridges in the broad belt of Pliocene and Pleistocene sediments north of the Santa Clara Valley and west of Santa Paula Creek are roughly conformable, suggesting that the ridges once formed part of a surface sloping downward from the late mature top of Sulphur Mountain across the Sulphur Mountain fault; but the rocks being very soft, the remnants of this surface have been much worn down below their original level. All of these occurrences taken together seem to outline in a general way an old land surface that had been subjected to considerable erosion since the deformation of the region and that was later uplifted essentially undisturbed and cut into by streams with a lower base level. For this surface the name Timber Canyon surface is proposed because one of its most clearly preserved remnants is the surface of the Timber Canyon fanglomerate.

The land surface just described probably corresponds to one or more of the marine terraces recognized along the coast. As the uplift of the district continued, several terraces were formed. Of particular note is the terrace that runs along the coast for many miles east and west of Santa Barbara and is followed by the highway and the railroad. It varies from a few feet up to 50 feet at the outer edge where it stands as a cliff above the ocean and rises to about 250 feet at the back. In the Santa Maria district, on the coast just around Point Conception to the northward, a similar terrace carves away the edge of a higher and much larger terrace known as the Burton Mesa, which, though obviously older than the Santa Barbara terrace, is probably younger than the Timber Canyon fanglomerate. The Burton Mesa has an elevation of about 300 feet at its lower edge, rising gradually to 500 feet in back where it gives way to a steeper slope which climbs to an altitude of 1000 feet or more. From the 1000-foot mark downward it is capped by a thin sand and conglomerate formation, stained reddish-brown and locally cemented by limonite. Pholad borings in pebbles and in the surface of the underlying truncated Monterey shales show that the capping formation is marine throughout. A probable explanation of this sloping terrace is that the district was forced downward by the deformation and was submerged up to present altitudes of 1200 feet or more, afterwards recovering gradually, the sea slipping away from the present hillside slowly and from the parts that now form the terraces somewhat more rapidly. With a broad, shallow submarine shelf extending probably far beyond the present shore line, perhaps like the shelf at Atlantic City, New Jersey, the force of the waves would all be expended in cutting down the bottom and would have no opportunity to cut back notches in the shore. Only thus can the marine capping formation, continuous over the slopes from terrace to terrace, be satisfactorily explained.

During the time of uplift, erosion, and terrace-forming, tremendous masses of the soft unconsolidated Pliocene and Pleistocene beds must have been removed. The magnitude of the work done was noticed by Eaton, who was led by it to assign an unusually great age to the early Pleistocene. From the correlations outlined below, it seems evident that Eaton did not allow sufficiently for the nature of the sediments nor for the fact that a local sand and mud pile, even though it be 5000 feet high, can be removed much more quickly than a uniform layer of that thickness extending over a wide area. It might be remarked that the old surface of Sulphur Mountain underlain by hard Miocene shales must have been exposed during most of the erosion interval, and yet it has been cut into around the edges only a few hundreds of feet.

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[1] Univ. Calif. Publ. Geol., Vol. 1, p. 157, 1893.

The regional elevation of the land was continued until the land all stood higher than at present. Rivers cut deep channels below their present levels, and these channels have had to be filled up subsequently with alluvium when the sea level returned to its present position. It even appears that for a brief time the sea level rose again to a point slightly higher than at present and that the alluvium deposited at that time was later cut into by the rivers when their base levels finally took their present positions. The younger fanglomerate of Timber Canyon has not yet been cut into, whereas that in the next canyon to the west has. Many of the other side canyons have very young, well-marked alluvium terraces (some of them as much as 50 feet high), and even the Santa Clara River itself is bordered by remnants of a very young terrace. The sea is now vigorously cutting away the Santa Barbara marine terrace, and it seems probable that if there ever was a very young marine terrace corresponding to the very young alluvial terraces of the river valleys, it may have been entirely removed by the waves.

The fauna of the Santa Barbara marine terrace is represented in the collections from localities 40, 74, and 78 S. D. S. N. H., and indicates that the terrace is very late Pleistocene in age and the temperature conditions about the same as at present. The not-so-warm aspect of this fauna throws doubt on the exact correlation of this terrace with the very similar Palos Verdes terrace at San Pedro and the La Jolla or Nester terrace at San Diego. It is probable, however, that it is not very different in age, and the more northern latitude, emphasized by a different configuration of the shore line, may account for its cooler facies. It is not unlikely that at the time of the formation of this terrace the Channel Islands, forming the southern rim of the Ventura basin, made a more continuous barrier, shutting off the warmer waters of the south and marking the limit of the range of many southern species.

The Los Angeles Basin

Most of the detailed information about the Pliocene of the Los Angeles basin is in the files of oil companies or in the form of confidential reports on foraminifera, most of which were not available during the preparation of this summary. The following account, therefore, must be made brief and rather general.

As in the Ventura basin, the Pliocene beds were deposited in the form of an overlap on the Miocene. In the Puente Hills[1] near the edge of the basin, heavy sandstones and conglomerates, especially in the lower part of the section, are indicative of shore-line conditions in an advancing sea. Farther out in the basin, however, the sediments are all finer grained, grading downward into the Miocene siliceous shales; and it is quite likely that there the deposition was continuous from the Miocene into the Pliocene. It is probable that the very base of the Pliocene occurs only in the center of the area of deposition, and that the sandstones and conglomerates in the Puente Hills were deposited, like the earliest Pliocene sediments of the San Diego embayment, sometime after the beginning of the Pliocene. The shore-line occurrences of the Puente Hills are not sufficiently well known faunally to show whether the Jacalitos zone is represented there or not, though this lower Pliocene zone is probably represented in the center and western part of the basin. The Pliocene strata in Temescal Canyon north of Santa Monica reported by Arnold[1] occupy a similar position, indicating overlap of the Pliocene onto the Miocene near the edge of the basin. The fauna there, though small, is characteristic of the San Diego zone as known both in its type locality and in the Ventura basin. Abundant *Pecten healeyi* and the brachiopod *Terebratalia* (or *Dallinella*) *occidentalis* Dall are good indices. Geologists and paleontologists have for the last few years been in the habit of calling the formation to which these strata belong Pico; but there is reason to believe that San Diego formation may be a better term, for the name is older and better characterized. The zone should at least be called the San Diego zone.

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[1] English, W. A.: "Geology and Oil Resources of the Puente Hills Region, Southern California," Bull. 768, U. S. Geol. Survey, especially pp. 39-44, 1926.

In the city of Los Angeles is a series of Pliocene strata with its base at the Miocene contact near the old Los Angeles oil field. Higher and higher horizons of the section outcrop southward until the uppermost is reached near the center of the city. Diagnostic fossils have not been reported from the base of the section, but Arnold[2] has given a list of species collected at the time of the digging of the Third Street tunnel. In this list "*Pecten ashleyi*," now known as *Pecten cerrosensis*, is indicative of the San Diego horizon, but *Pecten opuntia*, *Ranella oregonensis* var. *angelensis*, and *Buccinum* sp. are more characteristic of the Santa Barbara horizon. In other words, the fauna represents the upper part of the Pliocene in which nearly all of the species of the San Diego horizon have given place to the colder-water forms of the next stage. A similar but much larger fauna collected from excavations for an office building on Fourth Street between Broadway and Hill was described by Moody.[3] In Moody's list the principal survivor from the San Diego zone that is usually characteristic of that zone is *Pecten healeyi*; but this species is classed as uncommon, and *Pecten caurinus* and others are more characteristic of the Santa Barbara beds. Hence these two occurrences should be placed near the bottom of the Santa Barbara zone. The marine Pleistocene does not directly overlie this section.

The most important work on the Pleistocene of the Los Angeles basin is Arnold's San Pedro Memoir.[4] In it are carefully described and illustrated three of the most important zones of the middle and upper Pleistocene, termed by him the Deadman Island Pliocene, the lower San Pedro series, and the upper San Pedro series. Arnold thought the number of extinct species in the Deadman Island "Pliocene" sufficient to warrant assigning it to an older period; but since that time nearly all of Arnold's supposedly extinct species have been recognized in the living fauna, and very recent work in the San Pedro region has brought to light a rather thick underlying series of strata bearing a warm-water Pleistocene fauna[5] that is correlated, as explained below, with the Las Posas zone, formerly called basal "Saugus," of Ventura County. Thus we have in the lower Pleistocene the Las Posas zone, fairly thick and with a fairly warm-water fauna, the cold-water Deadman Island "Pliocene," or Timms Point zone as it will here be called, and the cool-water lower San Pedro series, or typical San Pedro zone, separated by very local unconformities; and then in the upper Pleistocene after the Coast Range mountain-building revolution and a period of erosion, the upper San Pedro series with another warm-water fauna. Tieje,[1] after Kew, has proposed to call the lower San Pedro series the San Pedro formation and the upper San Pedro series the Palos Verdes formation. Tieje has also proposed a name, Centinela gravels, for beds overlying what he thought to be the Palos Verdes in the Baldwin Hills and carrying a still warmer fauna.

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[1] Arnold, R.: Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907.

[2] Arnold, R.: *loc. cit.*, and Bull. 309, U. S. Geol. Survey, p. 152 (same list), 1907.

[3] Moody, C. L.: "Fauna of the Fernando of Los Angeles," Univ. Calif. Publ. Geol., Vol. 10, pp. 39-62, 1916.

[4] Arnold, R.: "The Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, California," Mem. Calif. Acad. Sci., Vol. 3, 420 pp., 27 ppl., 1903.

[5] Dr. Woodring of the California Institute of Technology described this warm-water zone a year ago at the meeting of the Cordilleran Section of the Geological Society of America.

The section described by Tieje in the Baldwin Hills appears to be more complete than that exposed at San Pedro not far away. Two cold-water zones are described, each of considerable thickness, overlain each by a warm-water zone, all of the zones being later deformed, truncated, and overlain by the ancient Los Angeles River gravels. In the light of present correlations it seems probable that the lower cold-water beds represent the Santa Barbara zone; the lower warm-water beds, the Las Posas zone; the upper cold-water beds, the Deadman Island "Pliocene," or Timms Point zone; and possibly the beds called "Palos Verdes" in the Baldwin Hills, the lower San Pedro series of Arnold, or the typical San Pedro zone. As explained below, the typical San Pedro zone is correlated with the beginning of an interglacial age and although its fauna may have represented cool-water conditions at the start it would not be surprising to find the cooler water sub-zone giving place to a warmer water sub-zone. According to Tieje's description, his "Palos Verdes" of the Baldwin Hills seems to underlie the main unconformity. Perhaps his Centinela gravels represent the true Palos Verdes.

Even if the whole sequence had not been found by Tieje in the Baldwin Hills, or if there should be some mistake in the identification of his zones, there would still be sufficient evidence to prove the presence of two cold-water zones separated by a distinctly warm-water zone and overlain by a zone of mild, perhaps in part of distinctly warm, temperature. In the Ventura basin the cold-water Santa Barbara zone is underlain by the warm-water Pliocene San Diego zone and overlain by the warm-water Pleistocene Las Posas zone. In the San Pedro district of the Los Angeles basin the cold-water Timms Point zone is underlain by a warm-water Pleistocene zone and overlain by another Pleistocene zone of apparently intermediate temperatures now to be called the typical San Pedro zone. As the two cold-water zones are of very similar faunal character, it is natural to consider correlating them, and, indeed, such a correlation is now on the point of being generally accepted; but the relations of these two cold-water zones to the warm-water zones above and below them show that a correlation between them is impossible. It would necessitate the correlation also of the lower warm-water Pleistocene zone of the San Pedro district with the San Diego Pliocene zone of the Ventura basin, unless it be argued that in the Ventura basin there are one or more zones missing between the Santa Barbara and the San Diego. On the north side of the Santa Clara Valley certainly and probably also in the city of Los Angeles the gradational nature of the lithologic and faunal transitions from the San Diego Pliocene to what is here called the Santa Barbara zone shows that the sequence is unbroken and that no important zone is missing. The San Diego Pliocene is so different faunally from each and all of the Pleistocene warm-water zones that a correlation between the San Diego Pliocene, whether of the San Diego, Los Angeles, or Ventura basins, with any Pleistocene faunal zone is entirely out of the question. Hence the discovery that the cold-water Timms Point zone overlies a warm-water Pleistocene zone, which could not through any possible mistake be the San Diego zone, proves that there are at least two different cold-water zones. The warm-water Pleistocene zone must itself be younger than the Santa Barbara zone of the Santa Clara Valley and the city of Los Angeles (for it cannot underlie it or be correlated with it); and if the Timms Point zone overlies this warm-water zone, it must also be younger than the Santa Barbara zone. The possibility that the beds here referred to as the Santa Barbara zone are not properly correlated with the Santa Barbara type section is not of importance for this particular consideration.

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[1] Tieje, A. J.: "The Pliocene and Pleistocene History of the Baldwin Hills, Los Angeles County, California," Bull. Amer. Assn. Pet. Geol., Vol. 10, pp. 502-512, 1926.

The lowest warm-water Pleistocene zone of the San Pedro region, being younger than the Santa Barbara zone of the Los Angeles and Ventura basins, is therefore the probable equivalent of the Las Posas zone of the Ventura basin, which is a warm-water Pleistocene zone of similar characteristics and at its type locality overlies the Santa Barbara zone. The zone at San Pedro must represent either the same interglacial age or a younger one. As the correlation with other regions shows that there is room for no larger number of major temperature alternations, this warm-water zone of the lower Pleistocene in the Los Angeles basin is here correlated with the Las Posas zone of the Ventura basin. The two sections have practically indistinguishable faunas. Each is the oldest known Pleistocene warm-water zone in its basin. Each is made up of a series of coarse and fine sediments many times, probably more than ten times, as thick as any other known Pleistocene zone in either basin, indicating a time of vigorous deposition. Failure to correlate the two would imply that there were two ages when conditions were suitable for vigorous deposition but that each age is largely or entirely unrepresented in the known deposits of one of the basins. It is improbable that under conditions favoring the deposition of several thousand feet of sediments in one basin there would be no similar deposits in a nearby basin which is shown by its other deposits to have been susceptible at the time to the deposition and subsequent preservation of sediments. The only other Pleistocene zone of the Los Angeles basin with which anyone might consider correlating the thick Ventura section is the typical San Pedro zone, which in comparison is insignificant in thickness and extent. Such a correlation is improbable, aside from the difficulty just discussed, that the lower warm-water zones would not match. The Las Posas zone is, then, younger than the Santa Barbara zone and older than the Timms Point zone. The Santa Barbara zone (upper Pliocene) can usually be distinguished by the presence of *Pecten bellus* and *Pecten opuntia* and possibly other species, which are of fairly regular occurrence in the Santa Barbara zone but are lacking or of rare or very doubtful occurrence in the Timms Point zone.

A summary of the lower Pleistocene marine record in the outer part of the Los Angeles basin may be given as follows:

(1) *Las Posas zone*, warm-water calcareous beds overlying the Santa Barbara zone in the Baldwin Hills area only, underlying the Timms Point zone on Second Street near Pacific Avenue, San Pedro, and most characteristically exposed in the Lomitas Quarry and in another quarry locally known among Los Angeles paleontologists as Hilltop Quarry, farther inland and higher up on the southeastern end of San Pedro Hill. R. D. Reed has worked out the sequence in San Pedro. Dr. Woodring of the California Institute of Technology has studied and described the localities mentioned, expressing his conclusions in the paper referred to above. The correlation with the Las Posas zone of the Ventura basin can be considered practically certain.

(2) *Timms Point zone*, a cold-water zone, predominantly clayey in lithology, formerly exposed on Deadman Island in San Pedro harbor, now typically exposed at Timms Point, San Pedro, where it overlies unconformably lower Pliocene or upper Miocene shales, and also exposed on Second Street, San Pedro, where it overlies the Las Posas zone unconformably.

(3) *Typical San Pedro zone*, a moderately cool-water zone, possibly grading up into a warm-water sub-zone, formerly exposed on Deadman Island, but now known only

from a few remnants at the foot of Second Street, San Pedro, where it is separated in apparently conformable sequence from the Timms Point zone by a section of cross-bedded unfossiliferous sands, in lithology not unlike some cross-bedded Pleistocene sands exposed along the highway in Grimes Canyon, Ventura County. The "Palos Verdes" of the Baldwin Hills may or may not belong to this zone. The "upper San Pedro" of Los Cerritos, now better known as Signal Hill, one of Arnold's original localities, recently described by Tieje in a paper given before the Pacific Coast Section of the American Association of Petroleum Geologists, probably belongs either to this or to the Las Posas zone. This last locality was originally assigned to the upper San Pedro (true Palos Verdes), because it was then thought that there was only one warm-water horizon in the Pleistocene. However, the beds are highly deformed, and Tieje suspected from the fauna that they might be older.

Recent workers in the San Pedro region have been applying the term *zone* to divisions of a distinctly lesser order of magnitude than the divisions outlined above. Pleistocene deposits have been divided into "zones" represented by strata a few feet or sometimes only a few inches in thickness. Perhaps it would be more convenient and more nearly in accord with general usages to call most of these fine divisions faunules and a few of them which could be recognized in two or three different outcrops and which would appear to indicate significant, though minor, changes in conditions sub-zones. Detailed studies such as are being carried on are sometimes useful in bringing out data on the equilibria of individual faunas and may occasionally indicate the trend of the major changes that were taking place. However, it must be considered that near-shore deposits such as are found throughout the Pleistocene were at the time of deposition subject to the fill and scour of ocean currents and to the local change of depth and other conditions so that none but the major reversals of temperature should be expected to persist in recognizable form for any considerable distances and minor variations in temperature should be expected to be of little use in making correlations.

In a very recent article,[1] Crickmay has described in this manner the stratigraphic succession at the well-known Deadman Island, an island that was formerly located in San Pedro harbor but has now been entirely removed by steam shovels. It is highly desirable that all available information about such a locality, made familiar to all California paleontologists by Arnold's early work, should be put on record, and the collections upon which this article is based and the detailed description of the deposits will in themselves be of sufficient value to repay the considerable amount of work that they must have required. However, it is difficult to agree either with the importance attributed to the fine faunal "zones" or with the interpretations of the faunal evidence. Perhaps if the fine divisions were called faunules there would be no temptation to assign them undue significance. It is argued, in particular, that in the Deadman Island "Pliocene," here called the Timms Point zone and correlated because of its cold-water fauna with a glacial age, there is not merely a single faunal zone but several "zones," some of which carry faunas indicating warm temperatures. If this were true there would already be known at San Pedro more major alternations in temperature than could be correlated with the known glacial and interglacial ages of other regions, and the presumption would be that still many more have not been recorded. If true, it would invalidate most, if not all, of the correlations of glacial ages that have so far been made. But the fact is overlooked that in such deposits as are found at San Pedro fine layers measured in inches are the playthings of storms and ocean currents, at most the products of local oscillations in the profile of equilibrium. Except when there are very long gaps in the depositional record, long diastems or intervals of subaërial erosion, the climate cannot change from warm to cold during the deposition of a foot or two of even moderately fine sediments. Furthermore, the chief reason in this particular case why the evidence for major temperature changes between faunules breaks down is that it is based on apparently erroneous interpretations of the thermal indications of various species. The argument hinges on the presence in certain faunules of so-called warm-water species, the accompanying cold-water species being explained away rather unconvincingly as washed in from deeper water or redeposited. But not a single species from one of these faunules of the Timms Point zone that was cited as indicative of warm temperatures is confined in its living range to southern waters. All range today north of San Pedro and some of them go far north. *Turritella cooperi*, *Pecten stearnsii* variety *diegensis*, *Mangelia hexagona* (cited as *Cytharella branneri*), and *Trivia ritteri* are known from Monterey Bay; *Fusinus barbarensis* and *Chama pellucida* are known from Oregon; and *Epitonium indianorum* was originally reported from the coast of Washington and is known abundantly in Alaska. *Cardita barbarensis* is only questionably distinct from other species of *Cardita* that are as a group common in Canadian and Alaskan waters. *Turritella jewetti* alone among the species of the Timms Point zone that are cited as southern in distribution goes no farther north than Santa Barbara, and it will be noticed that it is listed in that zone only as *Turritella* cf. *jewetti* and is said to be rare. Moreover, if one or two species that now range only in southern waters had been found in a predominantly cold-water fauna, it would not be surprising or particularly significant, for it must be recognized that the distribution of species is not wholly dependent upon temperature. The competition of other species probably has fully as much to do with it, and in some cases the distribution of temperatures throughout the year and a host of other minor factors have influence. In the past, some species have had a much more extended range than they have now, and some have had an entirely different range. *Crepidula princeps*, for instance, is abundant in some warm-water faunas in the Pliocene and Pleistocene; but its descendant, *C. grandis*, ranges only from the Arctic Ocean to Sitka, Alaska. Similarly, a few species of previously wide range may now be confined to warm waters. Therefore it must be concluded that no significant evidence has yet been submitted to show that there are any more major divisions in the lower Pleistocene of San Pedro than are outlined above, though it is possible that in the Timms Point zone of San Pedro there might be one or more less distinctly cold-water sub-zones.

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[1] Crickmay, C. H.: "The Anomalous Stratigraphy of Deadman's Island, California," Journ. Geol., Vol. 37, pp. 617-638, 1929.

The areas that remained land during the deposition of the Pliocene and lower Pleistocene sediments were reduced by erosion to a surface of low relief. This surface has been recognized as the Perris peneplain by English, who correlates with it the uplifted surface of the Bear Valley region of the San Bernardino Mountains.[1] This pre-deformation surface was subsequently dismembered, and all but the portions that were developed over areas of the older hard rocks have been obliterated. The remnants of this surface are usually not hard to distinguish from the post-deformation surfaces.

During the deposition of the lower Pleistocene sequence slight diastrophic movements had taken place, for the various zones are separated by unconformities; but these unconformities are chiefly erosional, involving only small angular discordances in dip. As the uppermost of these zones, the typical San Pedro zone, is involved in the major part of the folding, it is evident that the main deformation did not come until after the deposition of that zone. Furthermore, the compressive deformation that caused the folding of the beds had ceased before the cutting of the marine terraces, mentioned below, for the terraces are not disturbed by the folding that affects the beds underlying them. Apparently the compressive forces resulted in the depression of San Pedro Hill, which afterwards, in the succeeding time of readjustment, rose again, as shown by a series of a dozen or more well-marked marine terraces that extend almost to the top of the hill. Lawson has described most graphically these later Pleistocene marine terraces.[1] The lowest of these terraces is covered by a thin, richly fossiliferous marine deposit overlying horizontally the truncated edges of the pre-deformation series. This deposit, called the upper San Pedro series by Arnold, has been renamed the Palos Verdes formation. Its fauna is of a strikingly warm-water facies.

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[1] English, *op. cit.*, p. 64.

Other parts of the basin were affected differently during the readjustment after the deformation. Only along or near the coast are marine terraces recognizable, although an elevation of sea level to the top of San Pedro Hill would now cause the flooding of a vast area inland. The upthrusting of the great mountain blocks during the period of compression seems to have brought the inland areas as a whole to so high a level that the following reaction did not tend to uplift them further. Some of the intervening blocks had been downpressed and deeply covered with alluvium. It is unlikely, however, that the famous Rancho La Brea vertebrate accumulations belong to this time of the alluvium filling of downpressed blocks. They were situated on a block that was uplifted at the time, for the underlying beds were truncated before the asphalt deposits could begin to accumulate. It is much more likely that the Rancho La Brea alluvium and tar beds belong to the later time of alluvial accumulation represented by the older alluvial terraces. Afterwards the region as a whole rose again and the alluvium was partly scoured out. We may know only the base of what was once a much thicker brea deposit. The relative ages of the Rancho La Brea vertebrates and of the Palos Verdes invertebrates are not directly observable, but the antiquity of the vertebrate fauna and the youthful physiography of the Palos Verdes terrace suggest that the latter is somewhat younger. After the deposition of the Palos Verdes terrace material, the continent must have risen or the sea level subsided, causing the ocean to begin its task of cutting away most of the broad shelf that then extended outward from San Pedro. As explained later, the sea level probably stood lower on the land then than now and only in comparatively recent times returned to cut the present sea cliff in the edge of the overdeepened basin. The raised beach at Deadman Island mentioned by Arnold might indicate a slight uplift, perhaps local, or a lowering of sea level in very recent times.

The San Diego Basin

The geology and physiography of the San Diego region are described by Ellis and Lee,[2] and a later account is given by Hanna;[3] but in both of these papers the Pliocene deposits are very briefly treated. In an early paper, Dall discussed the "San Diego beds" and listed a fauna which he tentatively identified as Pliocene.[4] In 1902 the name San Diego formation was definitely applied by Arnold.[5] The second volume of the

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[1] Lawson, A. C.: Univ. Calif. Publ. Geol., Vol. 1, pp. 122-128, 1893.

[2] Ellis, A. J., and Lee, C. H.: "Geology and Ground Waters of the Western Part of San Diego County, California," Water Supply Paper 446, U. S. Geol. Survey, 321 pp., maps, illustrations, etc., 1919.

[3] Hanna, Marcus: "Geology of the La Jolla Quadrangle, California," Univ. Calif. Publ. Geol., Vol. 16, pp. 187-246, illustrations, map, 1926.

[4] Dall, W. H.: "Notes on Some Tertiary Fossils from the California Coast, with a list of the species obtained from a well at San Diego, California," etc., Proc. Calif. Acad. Sci., Vol. 5, pp. 296-299, 1874.

[5] Arnold, R.: Journ. Geol., Vol. 10, p. 130, 1902.

Memoirs of the San Diego Society of Natural History, now in process of preparation by L. G. Hertlein and U. S. Grant, will describe fully the occurrence and fauna of the San Diego Pliocene.

It appears that the part of the San Diego basin that is now exposed to view was depressed in the Pliocene either not so rapidly or not so early as the Ventura basin, and that consequently the marine transgression did not encroach upon the downwarped peneplain surface of the Eocene sediments until about the beginning of middle Pliocene time. Also the sediments had not become very thick before the sea retreated again beyond the present shore line, or else the younger parts of the deposits have been removed. Thus the San Diego formation, and it appears to be the only one of the named California formations of which this statement is true, is practically confined to the middle Pliocene. It probably corresponds roughly to the time of maximum marine invasion in other parts of southern California and Lower California, the sequence of events being much the same as in the shallower parts of the Ventura and Los Angeles basins.

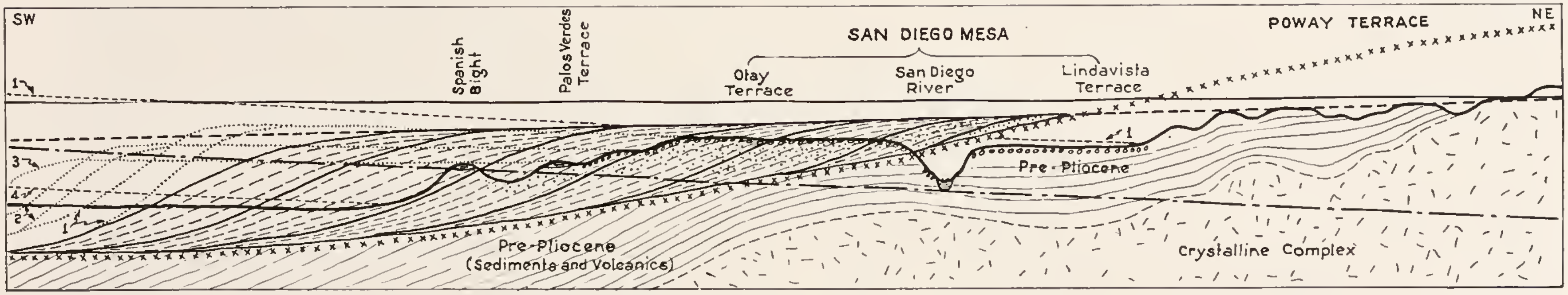
In the San Diego region the cycle began with marine transgression marked by a thin basal conglomerate overlapping on the slightly tilted Eocene. Fossils in the lower part indicate a rather warm climate, even including specimens of *Ficus,* subgenus *Trophosycon,* that evidently persisted longer in the San Diego region than they did farther north; but in the upper part cooler-water species began to appear. The marine retreat probably took place before the arrival of the extremely cold conditions of the Santa Barbara zone. Practically all of the characteristic species of the San Diego formation are known also from the middle Pliocene of the Ventura basin: *Cancellaria hemphilli, Terebra elata* variety *martini, Arca trilineata* typical variety and variety *calcarea, Venus* (*Chione*) *securis* variety *fernandoensis, Pecten purpuratus* varieties, *Pecten healeyi, Pecten estrellanus* variety *cerrosensis, Pecten swiftii* varieties, and the brachiopod *Terebratalia occidentalis,* besides many other species less characteristic of the middle Pliocene. There can be little reasonable doubt about the correlation of these middle Pliocene faunas, and it is for this reason that it is proposed to utilize the name San Diego in other basins.

Further information about the history of the San Diego formation and the conditions under which it was deposited can be made out from a study of physiography. The San Diego Mesa is the most conspicuous topographic feature of the region. Its broad, nearly flat surface, capped by a thin residual conglomerate, extends in a broad belt along the coast north and south of San Diego, nearly ten miles wide in places and many times longer. Although it has been uplifted and slightly tilted so that it is about 450 feet high in the northeast and 300 to 350 feet in the south and west, the rivers which cut across it have done no more than erode comparatively narrow canyons and have left most of the surface intact. The thin conglomeratic surface of the mesa overlies unconformably Eocene beds north of the San Diego River valley where the mesa has been called the Lindavista terrace, and southward it overlies unconformably the San Diego formation where the mesa has been called the Otay terrace; but the surface of the mesa is a single surface and should have but one name. At the edge of the San Diego Mesa, about two miles northeast of the northeasternmost outcrop of the San Diego formation, is the beginning of a higher surface known as the Poway terrace. It begins there at an elevation of about 700 feet and rises both eastward and northward, reaching 800 feet a mile and a half eastward and the same elevation five miles northward. It rises to greater elevations beyond. The Poway terrace is maturely dissected, being represented only by the approximately alligned crests of ridges. There may be higher surfaces also.

DIAGRAM C

IDEAL DIAGRAM SHOWING MARINE EROSION AND MARINE DEPOSITION ACTING SIMULTANEOUSLY IN THE PLIOCENE AND PLEISTOCENE OF SAN DIEGO

The Poway Terrace is the Counterpart of Pliocene and Lower Pleistocene Deposition; the San Diego Mesa, of Hypothetical Upper Pleistocene Deposition.


SW
NE
SAN DIEGO MESA
POWAY TERRACE
Spanish Bight
Palos Verdes Terrace
Otay Terrace
San Diego River
Lindavista Terrace
Pre-Pliocene
Pre-Pliocene (Sediments and Volcanics)
Crystalline Complex
1
3
4
2
1
1

++++++ Lower Pliocene surface of Eocene and older rocks. (The sediments above are Pliocene and Pleistocene; those below are Eocene and Cretaceous.)

——— Middle Pliocene sea level.

– – – – Middle Pliocene profile of equilibrium.

▨ Pliocene and lower Pleistocene sediments as originally deposited (upper Pliocene and lower Pleistocene hypothetical).

------- Upper Pleistocene sea levels.
1. Level during the cutting of the San Diego Mesa.
4. Level during the low-level stage of the last glaciation.

·············· Upper Pleistocene profiles of equilibrium and outlines of hypothetical deposits.
1. Profiles during the cutting of the San Diego Mesa.
2. Intermediate profiles.
3. Profile at the Palos Verdes stage.

ooooo Residual gravels left behind by the retreating Pleistocene sea and the rivers.

▭ Palos Verdes beach remnants.

—·— Present sea level (tilted in respect to the Pliocene level, which is shown horizontal).

⌒ Present surface profile (generalized). Deposits that were once above this line have been eroded away.

Scales only approximate: Horizontal, 1 inch = about 3 miles. Vertical exaggerated 10 times. Dips and slopes much exaggerated.

The Eocene beds underlying the San Diego Mesa have a slight dip to the east. There is reason to believe that the pre-Pliocene local forces, which evidently produced the major part of this eastward dip, may have continued or been revived at some time after the deposition of the San Diego formation, counteracting the southwestward tilting of the whole block, which probably took place at the same time, and leaving the San Diego beds with only the southward component of the dip. If allowance is made for this slight differential warping, it can be seen that the plain of the Poway terrace prolonged would originally have been roughly parallel with the bedding planes of the San Diego formation and hence may have been coincident with the submarine profile of equilibrium that controlled the top of the San Diego formation while it was being deposited. In other words, it is not unlikely that the Poway terrace is a plain of subaërial denudation, possibly in part a plain of submarine denudation, which once extended southwestward into the mid-Pliocene profile of equilibrium that was controlling the deposition of the San Diego formation. The terrace is developed over a large area of Eocene rocks, and hence it is not surprising that the San Diego formation is in some cases so similar to the Eocene lithologically that the separation can be made only on the basis of fossil evidence. The material of the San Diego formation is apparently the material cut away from the terrace and redeposited. It is possible that the suggested remnants of a still higher terrace represent the old peneplained surface of the Eocene and older rocks that had been tilted downward at the time of the Pliocene marine transgression; and, if so, these remnants should be dated physiographically from the end of the Miocene.

The age of the Poway surface cannot be stated exactly, but it is clear that its peneplaination was interrupted at some time after the middle Pliocene and before or at the time of the deformation of the region. The deformation, merely because of analogy with other regions, is assumed tentatively to be middle Pleistocene. There is no evidence to show that the deposition of sediments did not continue on the level of the Poway surface from the middle Pliocene through the lower Pleistocene until the time of the deformation. If it did, we should have no way of knowing it, for the sediments could only have been deposited at the outer end of the profile of equilibrium, west of the present shore line in the region now occupied by air and water. The ocean would have to attack this material and entirely remove the part that lay over the area that now is ocean before it could get in to cut the later terraces that we now know, for the deformation was not great enough in the comparatively stable region about San Diego to fault or fold these later beds down to a zone of safety. Until the time of the deformation, the Poway peneplain may have continued to develop, while the submarine surface extended itself seaward. Later the peneplain was highly dissected, while the part of the surface that had been submarine was entirely removed. If this is true, there is no necessity for believing that the sea withdrew and returned before the cutting of the last terraces; for all the terraces can be explained by one gradual intermittent marine retreat from the high level point near which it stood in the Pliocene.

The later history of the San Diego region is comparatively simple. At some time after the deposition of the San Diego formation, probably in the middle Pleistocene, the region was warped and tilted as outlined above. Sediments of uppermost Pliocene age and of the lower and middle Pleistocene before and during the time of the diastrophism have not been reported. After the diastrophism, the sea cut into the tilted Eocene and Pliocene sediments and produced the broad San Diego Mesa. The thin conglomeratic layer capping the mesa probably represents the material that the ocean did not carry out across the profile of equilibrium, that was left behind because too coarse to carry. Ellis and Lee have described three beach ridges that mark very brief pauses in the marine retreat from the area. Longer halts in the marine retreat are marked by steeper slopes between the lower terraces along the coast and by corresponding river terraces, the rivers keeping pace with the subsiding sea level and cutting canyons across the mesa. As on the Burton Mesa, the capping formation covers the slopes between the terraces as well as the more level parts of the terraces. The lowest terrace, known as the Nester terrace, sloping upward to the La Jolla terrace, has remnants of a fossiliferous deposit carrying a distinctly warm-water fauna like that of the Palos Verdes terrace in the Los Angeles basin. This terrace has been briefly described by Stephens.[1] The fossiliferous deposits may indicate a slight, temporary rise in sea level, or they may be merely better-preserved shore remnants. Finally, the shore line retired beyond the present coast, at which time the rivers cut their beds below their present levels and the ocean waves undoubtedly removed a large part of the terrain that once extended westward from the present shore. The return to the present sea level has caused the rivers to refill their valleys with alluvium.

Lawson has described the San Diego Mesa, the terraces at San Diego, and the very remarkable terraces on San Clemente Island and San Pedro Hill, together with similar occurrences in middle California, in one of the oustanding papers on the geology and physiography of California[2]. An amplification of the part on San Clemente Island was later given by Smith.[3] The working out of the physiographic history of the series of marine terraces that occur at various points along the coast is a very interesting and a very important problem. As yet, however, only a little is certain of the significance of these terraces, which are important clues to the age and relationships of the Pleistocene diastrophism and later deposition.

Coyote Mountain and Lower California Localities

Outcrops of fossiliferous deposits occur in the vicinity of Coyote (or Carrizo) Mountain in the western part of Imperial County (once a part of San Diego County) a few miles north of the Mexican boundary. Small patches of the same deposits are known as far north as San Gorgonio Pass at the head of the Coachella Valley, Riverside County, indicating the extent of the Gulf for a brief time at least when these sediments were being laid down. Although a number of paleontologists have studied the fauna of these beds and have formed opinions as to their age, the conflicting evidence that has been recorded does not allow a satisfactory determination of the age that is any more exact than lower Miocene, middle Pliocene, or some time between. The chief cause of the difficulty is that the fauna belongs to the Gulf of California province and is entirely different from anything else known in California. Even the Recent fauna of the Gulf of California, which is very imperfectly known, is almost as distinct from the Recent fauna of the open Pacific coast of California as is the Coyote Mountain fauna. In addition, the fossils are for the most part embedded in coarse conglomeratic sediments and occur in abnormal assemblages of numerous individuals of comparatively few species, sometimes stunted or distorted, as is often the case with faunas living at the heads of embayments in which the water is likely at times to become somewhat brackish. It may be for this reason that many of the normal constituents of the fauna are not represented.

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[1] Stephens, F.: "Notes on the Marine Pleistocene Deposits of San Diego County, California," Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 245-256, 1929.

[2] Lawson, A. C.: "The Post-Pliocene Diastrophism of the Coast of Southern California," Univ. Calif. Publ. Geol., Vol. 1, pp. 115-160, 1893.

[3] Smith, W. S. T.: "A Geological Sketch of San Clemente Island," Eighteenth Annual Report, U. S. Geol. Survey, Pt. 2, pp. 459-496, 1898, illustrated with photographs and a map.

The fossiliferous beds of the Coyote Mountain district overlap with marked unconformity the truncated edges of ancient metamorphics, Paleozoic sediments, and other formations, and in places overlie a series of Tertiary volcanic rocks such as are found almost characteristically in the middle Miocene of a number of regions in southern California. Upwards the fossiliferous beds grade into a thick series of brackish-water and non-marine sediments which may represent the remainder of Tertiary and lower Pleistocene time. As in other districts, the whole series is deformed and overlain by late Pleistocene terrace materials. The relation with the volcanics suggests that the marine beds are late middle Miocene or younger. W. P. Woodring has found basaltic flows interbedded with the fossils in one part of the district, and these basaltic flows are, then, presumably younger than the main body of the volcanics. However, the final determination of the age of the fossiliferous beds should be based on the fauna.

Since the Recent fauna of the Gulf of California has become better known, a large number of the Coyote Mountain species have been identified with species of the Recent fauna. There has been a tendency to correlate the marine deposits of the Coyote Mountain district with other formations known to be of Pliocene age and to call the age lower Pliocene. In a recent paper,[1] Hanna collected the current knowledge of the fauna and was inclined to believe that a greater portion of the fossiliferous formation is middle and upper Pliocene. In the systematic paleontology part of the present paper, the fossils have been considered Pliocene, usually lower Pliocene, in deference to the opinions of Arnold, Kew, Vaughan, and Hanna. If the age is Pliocene, it is not unlikely that the deposits belong to the time of maximum submergence in other regions, represented by the San Diego formation and the Pliocene deposits on Cedros Island and at numerous other places in Lower California, the age of which is believed to be middle Pliocene. On the other hand, the sequence of events may correspond to that found in northern California and Oregon, where the oldest beds of the late Tertiary sedimentary cycle are thought to be of upper Miocene age; but it seems more probable that it would correspond to the sequence found in less distant, southern localities. The fauna, like the middle and lower Pliocene faunas of other parts of California, contains a few distinctive species that are now extinct, at least in the Pacific. *Cassis subtuberosa* Hanna, for instance, has an antique appearance and recalls the large Pliocene *Trophosycon* of southern California. The interesting fact about these species that are no longer living in the Pacific is that most of them are conspecific with or closely related to species of the Caribbean. Consequently, if they are of Pliocene age, they must have lived over in the Pacific from the Miocene, when there was a connection with the Caribbean, and continued, as they might be expected to do, until extinguished by the cold wave of the first glaciation. A number of these Caribbean species have even survived the glaciation and can be recognized in the Recent fauna. However, W. P. Woodring has recently made a careful study of the Coyote Mountain fauna, the results of which have not yet been published, and has expressed the opinion, probably because of the presence of so many Caribbean species, that the age is lower Miocene. Apparently Dickerson had come to a similar conclusion.[2] Hence the age must still be left in doubt.

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[1] Hanna, G. D.: "Paleontology of Coyote Mountain, Imperial County, California," Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, pp. 427-503, 10 pls., 1926.

[2] Dickerson, R. E.: "Mollusca of the Carrizo Creek Beds and Their Caribbean Affinities," Abstract, Bull. Geol. Soc. Amer., Vol. 29, p. 148, 1918.

The most promising method of settling the question and the one that will probably be the most satisfactory in the end is to correlate the Coyote Mountain beds with similar deposits that occur from place to place along the Gulf coast of the Peninsula of Lower California. These deposits carry abundant fossils and should reveal what the normal Gulf fauna was at the time, and toward the tip of the Peninsula the Gulf fossils should mix with a Pacific fauna, the age of which is definitely known. The equivalent of the Coyote Mountain fauna has been reported from the vicinity of Santa Rosalia. Also, about 75 miles south of Santa Rosalia in the arroyos north of Loreto, Hanna and Hertlein have reported a fauna containing practically the whole of the *Pecten* assemblage, especially if *P. dallasi* is the same species as the *P. sancti-ludovici* reported by Hanna from Coyote Mountain and if "*Pecten* cf. *mortoni* Ravenel" represents a left valve of *P. keepi*.[1] Hanna and Hertlein considered the beds near Loreto and similar occurrences that they reported in the same paper all Pliocene and correlated them with a previously reported Pliocene fauna from Maria Madre Island, which is situated off the mainland of Mexico south of the Gulf.[2] At the last locality diatomaceous Monterey-type shales are said to lie unconformably below the Pliocene deposits. However, the correlation of the Loreto deposits with the Maria Madre Island Pliocene is very uncertain and the opinion that the age of the Loreto deposits is Pliocene may be based on the assumption that the Coyote Mountain beds are Pliocene. On the west coast of Lower California both the Miocene and Pliocene have been definitely recognized.[3] The best known Pliocene locality is on Cedros Island, where specimens were obtained that were early described by Gabb, Arnold, and possibly others. This locality can be correlated with the San Diego formation, middle Pliocene. There are also Pleistocene marine deposits in Lower California, but the details of their stratigraphy are not well known. In places, terraces are exceedingly well developed.

The San Joaquin Basin

North of the Ventura basin, the best known Pliocene deposits occur in the middle and southern part of the great San Joaquin trough, the great structural depression between the Sierra Nevada and the Coast Ranges. The important works on the Pliocene deposits of this basin are by Arnold,[4] Anderson and Arnold,[5] Anderson and Pack,[6] Nomland,[7] and Pack.[8] A recent study of the molluscan fauna from the cores of several wells drilled in the southern part of the San Joaquin basin in exploration for oil, together with the published literature on the region, indicates that the later Cenozoic history of the region is comparable to that of the Ventura basin.

At the end of the Miocene, the Santa Margarita sea retreated from the edges of the basin, and terrestrial, lacustrine, or brackish water beds were deposited. In the faunal rearrangement that took place the Pectens of the *Pecten discus* group became extinct and many of the other species, although not actually dying out at that time, found conditions where they had lived before unfavorable and migrated elsewhere. Around the edges of the basin there is evidence of an erosion interval and locally of an angular unconformity, suggesting that local forces may have caused the marine retreat and readvance at this time. However, the widespread occurrence of this phenomenon at times which are shown by faunal evidence to be approximately contemporaneous lends weight to the view that the forces were more than local.

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[1] Hanna, G. D., and Hertlein, L. G.: Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, pp. 137-157, pl. 5, 1927. See especially localities 794 and 795 of the California Academy of Sciences on p. 144, locality 797 on p. 146, and localities 844 and 845 on p. 150.

[2] Jordan, E. K., and Hertlein, L. G.: Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, pp. 209-217, pl. 23, 1926.

[3] Hertlein, L. G., and Jordan, E. K.: "Paleontology of the Miocene of Lower California," Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, pp. 605-647, pls. 17-21, 1927.

Jordan, E. K., and Hertlein, L. G.: "Contribution to the Geology and Paleontology of the Tertiary of Cedros Island and Adjacent Parts of Lower California," Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, pp. 409-464, pls. 27-34, 1926.

[4] Arnold, R.: "Paleontology of the Coalinga District, Fresno and Kings Counties, California," Bull. 396, U. S. Geol. Survey, pp. 22-101, ppl. 11-30, Jan. 15, 1910.

[5] Anderson, R., and Arnold, R.: "Geology and Oil Resources of the Coalinga District, ... ," Bull. 398, U. S. Geol. Survey, 354 pp., map, 1910.

[6] Anderson, R., and Pack, R. W.: "Geology and Oil Resources of the West Border of the San Joaquin Valley North of Coalinga," Bull. 603, U. S. Geol. Survey, 220 pp., map, 1915.

[7] Nomland, J. O.: "The Etchegoin Pliocene of Middle California," Univ. Calif. Publ. Geol., Vol. 10, pp. 191-254, pls. 6-12, 1917.

[8] Pack, R. W.: "The Sunset-Midway Oil Field, California," Prof. Paper 116, U. S. Geol. Survey, 180 pp., maps, 1920.

As the Pliocene sea advanced slowly and in an oscillatory fashion, the oldest Pliocene deposits are found only in what was at that time the lower part of the basin, and in places they interfinger with non-marine beds. Vertebrate bones found in these non-marine beds north of Coalinga afford a check on the age and confirm the invertebrate and stratigraphic evidence that the beds belong to the lower Pliocene.[1] These lower Pliocene beds were named by Arnold and Anderson the Jacalitos formation, and the faunal zone which they represent is known as the *Chione elsmerensis* zone. Nomland has already pointed out the faunal correlation with the beds at Elsmere Canyon; and this correlation has been confirmed in the part of the present paper dealing with the Ventura basin. Furthermore, the similarity in position of the two occurrences with regard to the sedimentary cycle is evident and may be of considerable significance.

In the middle Pliocene, the sea transgressed still farther, with perhaps minor diastrophic readjustments, and in a number of places around the edges of the basin the tip of the marine wedge representing the time of maximum marine invasion is found overlapping on lower Pliocene non-marine beds or older formations. Arnold and Anderson called the middle and later part of the Pliocene sequence the Etchegoin formation, believing because of the overlaps that it rests unconformably on the lower or Jacalitos beds. Nomland considered the unconformity a minor feature; and showing that the faunas in the whole of the Pliocene sequence form a natural unit, he proposed to call the whole sequence the Etchegoin formation, dividing it into four faunal zones, only the lower of which corresponds to Arnold and Anderson's Jacalitos:

4. *Mya japonica* zone
3. *Pecten coalingensis* zone
2. *Turritella nova* zone
1. *Chione elsmerensis* zone (Jacalitos)

As explained in discussing the Ventura basin, Nomland's second and third zones, or the lower part of Arnold and Anderson's Etchegoin, correspond to the middle Pliocene (Pico) of the Ventura basin and to the San Diego formation at its type locality. The characteristic species that these occurrences have in common are given above. There are many other species in common also, making the percentages quite high; but as these other species occur in practically all Pliocene deposits, and many of them are also Miocene and Recent, their presence is not significant. Arnold and Anderson have recognized several other zones, such as the *Glycymeris* zone, the lower *Mya* zone, the "*Mulinia*" zone, and the *Echinarachnius* zone (the echinoid *Echinarachnius* now known as *Dendraster*); but these zones are very local in distribution. In the southeastern corner of the basin, between Tulare and Bakersfield, is a zone in the lower part of the Etchegoin in which *Cryptomya californica* is very common. This zone is quite important, as it usually occurs not far above the oil-producing horizon. It is not certain whether it should be assigned to the Jacalitos or to the lower part of the Etchegoin as defined by Arnold and Anderson; but in a well drilled in exploration for oil near Tipton, Tulare County, it occurs beneath a considerable thickness of Etchegoin at the base of the marine Pliocene, and it seems to be a zone distinct from the overlying parts of the section. In the Bakersfield region it is the only marine Pliocene represented, the point of the wedge denoting the time of maximum marine invasion. It is tentatively called lower middle Pliocene.

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[1] Merriam, J. C.: "Tertiary Vertebrate Faunas of the North Coalinga Region of California," Trans. Amer. Phil. Soc., Vol. 22, pp. 191-234, 1915.

During the remainder of the Pliocene the sea retreated in an oscillatory manner from its point of greatest advance. In the well mentioned above there are beds indicating at least four well-marked alternations between marine and non-marine conditions, the lowest of these beds being separated from the underlying *Cryptomya californica* zone by a thick non-fossiliferous wedge. The non-marine beds in this upper part of the section are non-fossiliferous or contain leaves, bullrushes, etc. In the southwestern part of the basin the marine strata alternate with deposits bearing abundant lacustrine mollusca. The uppermost marine beds throughout the basin are characterized by very abundant, closely packed *Mya*, here referred to *Mya arenaria* variety *japonica*, and this zone is commonly called the *Mya japonica* zone. *Mya* is not only a frequenter of mud flats such as must have prevailed in the San Joaquin basin at the time, but its natural habitat is in cold or arctic waters, and its great abundance at the top of the Etchegoin and the presence of other cool-water species are taken as evidence of the approaching cold of the glacial epoch. Thus there is good reason for assigning the *Mya japonica* zone to the upper Pliocene and for correlating it as a mud-flat facies of the Santa Barbara zone.

After the deposition of the *Mya japonica* zone, non-marine conditions prevailed uninterruptedly, the marine strata giving place in the southeast to alluvial deposits, and in the southwest to the Tulare lake sediments. The upper part of the Kern River alluvial formation may belong to this part of the geologic column, but vertebrate paleontologists have recognized in part of this formation a fauna of Etchegoin age. Practically always these overlying non-marine beds, most of which are here considered lower Pleistocene in age, are entirely conformable with the Etchegoin, and only in one place are they reported to be unconformable.[1] Not until the great diastrophic upheaval of the middle Pleistocene was the great mass of the Pliocene sediments disturbed, and then the Tulare in the west and the Kern River in the east together with the marine formations were upturned against the edges of the present basin. Since that time erosion of the edges of the basin and filling of the center with alluvium is all that has taken place.

The Sierra Nevada

Recent investigations by Professor Blackwelder and his students have disclosed some very significant new information about the glaciations in the Sierra Nevada.[2] Four glaciations can now be recognized. The oldest is known from remnants of moraines on the tops of some of the highest ridges, the position of these remnants showing that the main uplift of the region did not take place until the following interglacial age. The uplift caused the cutting by stream action of valleys to a depth of about two thousand feet, at which stage the second glaciation came on and left moraines on the valley sides and floors. After the second glaciation, stream erosion was resumed and cut the valleys about a thousand feet deeper. The moraines of the second glaciation are now found only in isolated patches above the shoulders of the canyons. The third and fourth glaciations, separated by a comparatively brief interval, took place almost entirely within the canyons, carving the canyon forms much as we see them today, for since the last glaciation the rivers have done but little to obscure the glacial topography. As explained below, the discovery of the earlier glaciations (only the last pair was known before), makes it possible to recognize the correlation with the three main glaciations of northern Europe, and helps materially in checking the correlation of the California marine section with the European divisions.

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[1] Pack, R. W., and English, W. A.: "Geology and Oil Prospects of Waltham, Priest, Bitterwater, and Peachtree Valleys, California," Bull. 381d, U. S. Geol. Survey, pp. 119-160, 1915, see especially p. 134.

[2] Blackwelder, E., Bull. Geol. Soc. Amer., Vol. 40, p. 127, 1929.

The Coasts of Middle and Northern California

When knowledge of the geology of the Coast Ranges was still in its infancy, Lawson wrote two papers in which, among other things, he described the Merced series of middle California and the Wildcat series of northern California.[1] Even at that time the general features of the deposits and the parallel sequences of events were outlined substantially as they are known today. Soon after publishing the first description of the Merced series, Lawson added further observations and inferences.[2] Diller described and illustrated the topographic features of northern California and Oregon.[3] Later Hæhl and Arnold described a new formation, the Purisima formation, with its type locality not far south of the type locality of the Merced;[4] and this formation was subsequently mapped in the Santa Cruz Folio.[5] More recently Lawson has mapped the distribution and structure of the Merced and later formations in the San Francisco Folio.[6] Finally, Martin reviewed the literature and summarized the stratigraphy and faunas of the various Pliocene and supposed Pliocene occurrences of middle and northern California.[7]

The literature indicates that in the Santa Cruz quadrangle where the Purisima formation was first described, and northward on the San Francisco Peninsula where the Merced was first described, and in northern California where the Wildcat series occurs, essentially the same sequence of events took place. Lithologically the three groups have a marked similarity, consisting of a basal conglomerate, a higher shale, and an overlying sandstone or conglomerate. Except for the Merced, where unfortunately most of the lower beds appear to have been cut out by the San Andreas fault, the lower parts of some of the sections include beds which have a suggestion of Miocene lithology, with brownish or siliceous shale in contrast to the more characteristic soft gray beds with occasional locally cemented hard calcareous strata of the upper parts of the sections. The faunas also have a Miocene aspect, though it will be noticed that practically all of the species thought to indicate a Miocene age are also reported either from the Merced, the upper Purisima, the upper Wildcat, or the Coos conglomerate of Oregon, all of which are conceded to be of post-Miocene age. In other words, the view that the lower parts of these formations are of Miocene age recalls the early opinions about the Jacalitos and

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[1] Lawson, A. C.: "The Post-Pliocene Diastrophism of the Coast of Southern California," Univ. Calif. Publ. Geol., Vol. 1, pp. 115-160, 1893, "The Merced Series," pp. 142-150.

————: "The Geomorphogeny of the Coast of Northern California," Univ. Calif. Publ. Geol., Vol. 1, pp. 241-272, 1894, "The Wildcat Series," pp. 255-261.

[2] Lawson, A. C.: "Sketch of the Geology of the San Francisco Peninsula," Fifteenth Ann. Rept. U. S. Geol. Survey, pp. 401-476, 1895, "The Merced Series" and "The Terrace Formations," pp. 459-465.

[3] Diller, J. S.: "Topographic Development of the Klamath Mountains," Bull. 196, U. S. Geol. Survey, 1902.

[4] Hæhl, H. L., and Arnold, R.: "The Miocene Diabase of the Santa Cruz Mountains in San Mateo County, California," Proc. Amer. Phil. Soc., Vol. 43, pp. 15-53, 1904, "The Purisima formation," pp. 22-28.

[5] Branner, J. C., Newsom, J. F., and Arnold, R.: Folio No. 163, U. S. Geol. Survey, 1909.

[6] Lawson, A. C.: Folio No. 193, U. S. Geol. Survey, 1914.

[7] Martin, B.: "The Pliocene of Middle and Northern California," Univ. Calif. Publ. Geol., Vol. 9, pp. 215-219, 1916.

Elsmere Canyon faunas; and the difficulty may be caused by our unfamiliarity with the cold-water northern Pliocene faunas and the confusion that has always prevailed at Coos Bay.

As to the relations of the Merced and Purisima formations, it seems hardly possible that occurring so close together and having so many characters in common they could have originated entirely independently. The failure to make the correlation seems to be due to a peculiar distribution of species, the Pectens upon which most of our faunal correlations are based being absent from the Merced. According to Branner, Newsom, and Arnold: "The typical Merced fauna is distinguishable from that of the upper portion of the Purisima more by the absence of certain forms common in the latter than by the presence within the Merced of any unique species." Only the echinoid *Dendraster interlineatus*, common in the Merced, is said to be lacking in the Purisima; and wherever this species occurs in the Santa Cruz quadrangle in beds that look like Purisima, even though the beds lie directly and conformably above the basal conglomerate of the Purisima, the formation at that place is mapped as Merced. Unfortunately, nowhere has the Purisima fauna been found above the *Dendraster interlineatus* beds, but one of the missing Pectens was found by Martin in the area at Pillar Point which is likewise mapped as Merced. Furthermore, *Pecten turneri* from the Merced north of San Francisco appears to be only a poorly preserved *Pecten purisimaensis*. There is an upper or Pleistocene section of the Merced separated from the lower by a fault or unconformity, but it is not represented in the Purisima area and does not figure in the above discussion.

Thus it appears that the Merced series, though all of the lower part except the very base is lacking, and the Purisima series, though the upper part is in most places removed by erosion, represent essentially the same unit of deposition or sedimentary cycle, and that the Wildcat series of northern California is also essentially the same.

The nature of the break between the Pliocene and the Pleistocene parts of the Merced series is masked by a landslide over the beach section, and apparently the upper Pliocene is missing. All the species in the upper Merced are still living, and the deposit correlates well with the lower Pleistocene in southern California. The folding and faulting of the Merced series and the uplift of the Montara Mountain block came afterwards. Unconformably above the Merced series and the older (Mesozoic) rocks alike lie the practically horizontal, unconsolidated, upper Pleistocene terrace deposits.

Lawson has described two old terraces on the back slopes of Montara Mountain near the type locality of the Merced. They are represented by the tops of Sawyer and Buriburi ridges at elevations of 1150 and 700 feet respectively; but as these ridges are separated by the San Andreas fault, it seems not unlikely that the two levels represent the same terrace. This terrace is probably the equivalent of one of the terraces along the coast, perhaps of approximately the same age as the Timber Canyon surface of the Ventura basin; but it has been maturely dissected, and it is barely possible that it was cut, like the Poway terrace at San Diego, during the deposition nearby of the Pliocene and Pleistocene marine sediments, later being uplifted with Montara Mountain at the time of the middle Pleistocene deformation.

Diller (above referred to) describes a number of old land surfaces in northern California, some of which are probably related to the Wildcat series. Diller considered the Wildcat series Miocene because of Dall's determination of the fauna, although Gabb and Merriam and Lawson had previously recognized the Pliocene age of the series. Even Martin thought that there might be some separation of the basal Wildcat beds and "Bear River Miocene" into an upper Miocene part of the series, but it now seems probable that the whole represents a single Pliocene unit. The Klamath peneplain is the most clearly marked of the surfaces recognized by Diller. Apparently Diller thought that this ancient peneplain was in process of formation up to and including the time of deposition of the Wildcat series and that not until after the deformation of that series (now believed to have taken place in the middle Pleistocene) was it encroached upon by a surface of lower base-level. Its age would then be lower or middle Pleistocene. It is probable that the old peneplain had been warped and partially uplifted at the time when the coastal area about the mouth of Eel River was depressed to admit the invasion of the lower Pliocene sea. Remnants of old terraces in the San Diego region must have been uplifted before the formation of the Poway terrace and may correspond roughly to the early stage of the Klamath peneplain. The end of the Miocene is known to have been a time of general deformation, the only important one before the mid-Pleistocene revolution. This earlier period of deformation was formerly thought to have come in the middle Miocene, but in some cases at least the supposed Miocene beds above the angular unconformity (Sargent oil field, Santa Cruz quadrangle, etc.) have since been shown to be Pliocene. If this is the case, the early stage of the Klamath peneplain, and possibly the old San Diego terraces, may be assigned tentatively to the end of the Miocene.

With the uplift of the highlands, may have been formed the older valleys of the Klamath region; and at the time of maximum marine invasion, in the middle Pliocene, may have been formed the peculiar semi-marine inland deposits at Hay Fork described by Diller. Later, perhaps in the mid-Pleistocene, though there is no evidence for the time except analogy, the Wildcat series (like the Merced and like the beds in the Ventura basin) was deformed and the whole of the north coastal region was uplifted in stages, forming the marine and the later valley terraces, the sea finally retreating to a position below its present level and not returning until Recent times to cut away the outer edge of the last terrace. There seems to be no conclusive evidence of more than one great uplift when the sea level stood at the continental border and no reason to believe that the uplift came before the upper Pleistocene or earlier than the time just succeeding the middle Pleistocene deformation. Diller's postulation of two such uplifts, the first followed by subsidence, does not seem to be well substantiated.

The Coast of Oregon and Northward

In the Coos Bay Folio, Diller described some later Tertiary and Quaternary deposits as the Empire formation and the Coos conglomerate respectively.[1] Later, Dall monographed the fauna,[2] assigning the Empire formation to the Miocene and the Coos conglomerate to the Pleistocene. Much later, Howe restudied the section described by the older workers and pointed out[3] that the fauna listed by Dall from the Coos conglomerate contains only three species not contained in the underlying Empire formation and that of these three Dall recorded only one as living. Hence Howe concluded that it is illogical to consider the Empire Miocene and the Coos conglomerate Pleistocene; and he assigned both to the Pliocene, while recognizing an erosion interval between them. Arnold and Hannibal,[4] and Hertlein and Crickmay[5] have also published papers, one before and the other after Howe, summarizing the Tertiary stratigraphy of the Northwest and mentioning the Coos Bay formations.

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[1] Diller, J. S.: Folio No. 73, U. S. Geol. Survey, 1901.

[2] Dall, W. H.: "The Miocene of Astoria and Coos Bay, Oregon," Prof. Paper 59, U. S. Geol. Survey, 278 pp., 23 ppl., 1909.

[3] Howe, H. V.: "Faunal and Stratigraphic Relations of the Empire Formation, Coos Bay, Oregon," Univ. Calif. Publ. Geol., Vol. 14, pp. 85-114, 1922, especially p. 87.

[4] Arnold, R., and Hannibal, H.: "The Marine Tertiary Stratigraphy of the North Pacific Coast of America," Proc. Amer. Phil. Soc., Vol. 52, pp. 559-605, 1913.

[5] Hertlein, L. G., and Crickmay, C. H.: "A Summary of the Nomenclature and Stratigraphy of the Marine Tertiary of Oregon and Washington," Proc. Amer. Phil. Soc., Vol. 64, pp. 224-282, 1925.

It is difficult from the literature extant to form a definite opinion of the age of these Oregon beds. The Coos conglomerate, as mentioned by Howe, lies unconformably under horizontal terrace deposits and must therefore antedate the mid-Pleistocene deformation. Judging by its fauna and induration it seems probable that Howe was right in considering it Pliocene, though it must be remembered that many of the species reported from it, as is recognized by all writers on the subject, are redeposited in large and small fragments from the Empire formation. For the time being then, the occurrences in the Coos conglomerate will be reported as Pliocene; and merely because the weight of opinion seems to point this way, not because the evidence is believed to be any stronger for this view than for the other, occurrences in the Empire formation are reported as upper Miocene. The stratigraphic relations and the similarity of the Purisima and lower Wildcat faunas even favor Howe's view. Dall's refusal to recognize Recent species may have given the fauna an artificial appearance of antiquity. On the other hand, the Empire formation is correlated with the Montesano of Washington, which is still considered upper Miocene.[1] To follow out to logical conclusions the views previously expressed in this paper would necessitate placing both the Empire and the Montesano formations in the lower Pliocene because of their stratigraphic and faunal relations; but reasoning based on the scanty evidence available in the literature is not sufficiently reliable to warrant so radical a change.

Dall has from time to time reported Miocene and Pliocene occurrences in Alaska, and in some cases references to these reports are included in the systematic paleontology part of the present memoir. Without further reference to the literature of Alaska it would be unwise to discuss the age of these deposits, though it might be noted that Dall was always inclined to assign to formations too great an age. The raised beaches at Nome, for instance, sound more like Pleistocene than Pliocene.[2] A recent reviewer's note suggests that later information is available. Dr. Stephen R. Capps has recognized four glaciations in Alaska.[3]

Historical Summary of Conditions in California

At the beginning of the Miocene the region extending from the present sites of the Sierra Nevada and Cascade ranges to the edge of the continental shelf was a region of fairly low relief. Fine-grained Oligocene sediments had been deposited in Washington and Oregon, and a small belt of shales with some sandstone had been deposited in middle California; but the rest of the region, so far as there are records, seems to have been land. In southern California the conglomeratic sandstones of the Sespe formation indicate that there must have been mountains in the distance, but the remarkable regularity and extent of these non-marine beds indicates that the surface on which they were deposited must have been broad and very uniform.

Diastrophic movements or crustal warping on a large scale caused the lower Miocene or Vaqueros sea to transgress over this surface, depositing from middle California south to Orange County a basal sandstone of very uniform character with fossils of littoral habit. That this transgression was gradual is shown in the south by an interfingering with the terrestrial Sespe deposits; and consequently the Vaqueros formation does not always and may not ever in the regions now exposed to view represent the very bottom of the Miocene or the beginning of the crustal warping, but was deposited as the sea moved inwards at higher and higher horizons. As the shore phase moved eastward finer-grained sediments were deposited to the westward, gradually grading upward, with or without local break into the middle Miocene.

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[1] Weaver, C. E.: "Tertiary Faunal Horizons of Western Washington," Univ. Wash. Publ. Geol., Vol. 1, pp. 1-67, 1916.

[2] See Moffit, F. H.: "Geology of the Nome and Grand Central Quadrangles, Alaska," Bull. 533, U. S. Geol. Survey, 1913, especially pp. 40-49.

[3] Science, N. S., Vol. 71, Supplement, p. xii, Jan. 3, 1930.

As already explained in discussing the Ventura basin, the Miocene sequence exposed along the present coast from the Salinas Valley southward seems to be remarkably constant. Overlying the Vaqueros sandstone, sometimes with a gradational contact passing through buff sandy shales, and sometimes with a comparatively abrupt contact passing directly into soft gray micaceous or hard black shales with characteristic calcareous or dolomitic strata or concretions that weather a bright yellow color, are the siliceous shales, usually opalized below, but normal and finely laminated in the middle, and very light and porous at the top. The siliceous shales are usually assigned to the Monterey formation, middle Miocene. They are composed of volcanic ash and diatomaceous remains, the relative amounts of which have been the subject of considerable discussion.

Recently there has been a tendency to call the black shale overlying the Vaqueros sandstone Temblor, because it has been correlated by means of foraminifera with the middle Miocene shore phase in the San Joaquin basin, known as the Temblor formation. Among the mollusks, a marked change in fauna took place when the advancing Miocene sea had reached about half way to its position of maximum extension. The shore phase deposited from then on is usually called Temblor; and if the foraminifera, as mentioned above, show that certain shales deposited oceanward were laid down contemporaneously, the correlation is important. However, the beds correlated constitute more a faunal zone than a formation; and their position in the sedimentary cycle as the upper Vaqueros shale oceanwards and the basal Monterey sandstone shorewards should not be lost sight of. It appears now that the typical Temblor represents the lower middle Miocene and that the typical Monterey represents the upper middle Miocene; and such a relationship is quite to be expected if the former is the base and shore phase of the middle part of the Miocene cycle and the latter is the upper and oceanward phase. On the other hand, wherever local circumstances may have brought about shore conditions in the upper middle Miocene, the presence of Temblor fossils should not cause surprise; nor should the presence of Monterey fossils in lower middle Miocene sediments deposited in the oceanward parts of basins be wondered at. Perhaps foraminifera are less easily affected than mollusks by differences in facies, for their light tests are easily transported into all the different phases of a horizon. For this reason it may be possible with their help to recognize the Temblor as a horizon in addition to its being the shore and basal phase of the Monterey.

In the middle Miocene the shore line reached the Sierra Nevada, which even at that time must have had in places very steep slopes, for sands and conglomerates locally containing huge boulders, as in the southern end of the San Joaquin basin, were deposited by torrents flowing out from the slopes. Similar deposits on the west side of the San Joaquin basin indicate that there may have been islands or a ridge in that direction dividing the basin from the open ocean. The climate must have been arid, as it is today, and the torrents infrequent, for terrestrial sediments reached but a short distance from shore, and over the greater part of the submerged region, inland as well as along the present coast, fine white siliceous shales, very characteristic of this horizon, were deposited. With the few exceptions indicated by coarser sediments, the conditions of deposition in California seem to have been much more quiet and more uniform than topography like the present would allow. At least some of the islands that are recognized to have been present were probably volcanoes pouring forth lava and tuffaceous material and supplying silica favorable to the growth of diatoms.

In Washington and Oregon similar deposits were being laid down, except that the shales contain less siliceous material and the northern faunas are somewhat different. The northern occurrences include the Astoria beds of Oregon and the Clallam formation of Washington. At the same time, in the parts of the coastal belt from Washington and Oregon to California that remained land, particularly in northern California and probably in the San Diego region, the forces of erosion were presumably busy removing the remaining irregularities from the already nearly flat land surface and wearing it down to a peneplain.

It was formerly thought that at the end of the middle Miocene violent diastrophic movements upset the peaceful regularity of these processes, folding and faulting the newly laid deposits. It was thought that along the coast from middle California northward new areas of submergence were formed and a new cycle of sedimentation inaugurated. It is even now recognized that local disturbances and readjustments of this sort occurred, notably in the Santa Monica Mountains and in the San Luis Obispo region; but now more and more of the deposits overlying the stratigraphic break have been found to be Pliocene instead of Miocene in age, first the Jacalitos formation of middle California with which Pliocene vertebrates were embedded, then, in order, the Elsmere Canyon beds, the supposed upper Miocene ("San Pablo formation") of the Sargent oil field, the lower Purisima of middle California, and the lower Wildcat of northern California. Even the Empire of Oregon is being questioned, and if it also goes, the Montesano of Washington will go with it.

If the formations mentioned above are eliminated from the upper Miocene, the evidence from deposits undoubtedly of that age indicates consistently a normal continuation of the processes of the middle Miocene. There was a slight diastrophic readjustment, and the sea covered a few areas where it had not been before and abandoned a number of others. The major basins continued to fill up, and most of them, like the San Joaquin and Ventura basins, became very shallow toward their heads. Beds packed with oysters, some of them of very large size, were deposited, and in other places beds made up of large numbers of individuals of other single species, as if the water were becoming brackish. The upper Miocene is represented in middle and southern California by the Santa Margarita formation, which has been called the San Pablo group in the San Francisco Bay region and has been divided into the Briones, Cierbo, and Nivoly. Not until the basins had become very much restricted and deposition had almost ceased did the main widespread diastrophic movement take place.

Then the Pliocene marine cycle was inaugurated. The older sediments were folded, the land areas were warped so that new basins were formed and parts of the land areas were uplifted, starting a new erosion cycle and causing the streams to wash down coarser material. It is probable that the basin areas, being the weakest parts of the crust, would be affected most, especially around the edges, where bending or faulting would be concentrated, and that the stronger parts of the more resistant land masses would be uplifted with little or no deformation, preserving nearly intact the old land surfaces. Thus an early stage of the Klamath peneplain of northern California may be dated from this time, and possibly the older surface that appears as the highest terraces in San Diego County back of the Poway terrace. It is also probable that the major structures of the Coast Ranges were outlined at this time, and the basins as we know them today, though the great movements that brought about the present topographic relief did not take place until later.

Marine waters reinvaded the old basins, in places encroaching on the borders of the older rocks surrounding the basins, and invaded in a number of places entirely new areas of deposition. The marine overlap is usually recognizable by a littoral zone of coarser sediments, sometimes overlying an angular unconformity, the sediments above usually having a somewhat different lithology of grayish, softer sandstones and clays with very little of the siliceous material characteristic of the Miocene. In the centers of some of the larger basins, however, like the Ventura and Los Angeles basins, sedimentation seems to have been continuous from the Miocene into the Pliocene, and the line must be drawn chiefly on the basis of paleontologic evidence. The fauna of the lower Pliocene shows a change of character, though not always a marked change, from that of the upper Miocene. Several common species of Pectens dropped out or became scarce, and the last members of the genus *Agasoma* died out. Species and groups of modern character appeared. A few species more characteristic of the Miocene survived into the lower Pliocene, but most of them disappeared before the middle Pliocene. The names of the formations representing this basal Pliocene have already been mentioned: the Jacalitos, the Elsmere Canyon beds (+ the Santa Paula formation), the lower Purisima and the lower Wildcat, and, very hypothetically, the Empire and Montesano formations of Oregon and Washington.

In the middle Pliocene the marine invasion reached its maximum in most places and began a long, halting retreat. Whereas the fauna of the lower Pliocene consists entirely of warm-water constituents, that of the middle Pliocene begins to show toward the end an intermixture of newly arrived northern species. The various formations have been described above, and little can be added here: the San Diego, the Pico, the middle or lower Etchegoin, the Merced, the upper Purisima, the upper Wildcat, perhaps the Coos conglomerate. In the highlands the post-Miocene diastrophism had inaugurated a new erosion cycle, and during the lower and middle Pliocene river valleys were probably being cut as a result of that uplift. The erosion cycle may have reached late maturity in upper Pliocene or lower Pleistocene time.

The upper Pliocene, as has already been pointed out, is characterized by a fauna containing as large a proportion of species now living only in northern latitudes as is found in any of the coldest zones of the Pleistocene. The filling up of the basins and the restriction of the areas of deposition give the end of the Pliocene an aspect strikingly like that of the end of the Miocene; but the colder climate indicated by the fossils is something new and unusual. It is the cause for the extinction of so many species and the reason for the separation of the Tertiary and Quaternary periods. The upper Pliocene is represented by the *Mya japonica* zone of the San Joaquin basin and by the Santa Barbara beds of southern California.

Until a short time ago the lower Pleistocene was included in the Pliocene, partly because the Recent fauna was not so well known and many of the species now known to be still living were then thought to be extinct, and partly because the formations of this age were involved along with the Pliocene in the great diastrophic revolution of the late Cenozoic. Three lines of evidence now show that these beds are lower Pleistocene: (1) a revision of the faunas and check-lists shows that practically all of the species are still living; (2) the time of the diastrophic revolution has been dated by physiographic and vertebrate paleontologic evidence both in eastern California and on the Pacific

TABLE I

CORRELATION OF CALIFORNIA FORMATIONS

GENERAL	MIDDLE AND NORTHERN CALIFORNIA	SAN JOAQUIN BASIN	VENTURA BASIN	LOS ANGELES BASIN	SAN DIEGO BASIN
Alluvium	Alluvium	Alluvium and possibly later Tulare deposits	Alluvium Younger fanglomerate	Alluvium	Alluvium
Terrace deposits	Terrace deposits		Marine terrace and older fanglomerate	Palos Verdes (upper San Pedro series)	Pacific Beach Pleistocene, etc.
Deformation and erosion	Deformation and erosion	Deformation	Great deformation and erosion	Great deformation and erosion	Terrace cutting
Cool horizon	Paso Robles formation, terrestrial (and in part marine ?); Santa Clara beds, lacustrine; upper Merced, marine	Tulare and upper Kern River deposits	? Higher horizons	San Pedro zone (lower San Pedro series)	
Cold horizon				Timms Point zone	
Warm horizon, marine overlap			Las Posas formation	Las Posas zone	
Restricted basins and cold-water faunas	? Elk River beds (Cape Blanco, Ore.)	Etchegoin *Mya japonica* zone	Santa Barbara zone (*Pecten caurinus* clays)	Beds at 4th and Broadway Third Street tunnel	
Marine retreat	Upper Wildcat Upper Purisima Merced	Etchegoin *Pecten coalingensis* zone	San Diego zone (middle Pico) with *Pecten healeyi*, *Arca camuloensis*, *Astraea gradata*, etc.	San Diego formation in Temescal Canyon, Puente Hills, etc., with basal conglomerates	San Diego formation with *Pecten healeyi* and at the base *Ficus*
Maximum marine invasion in the south	? Coos conglomerate	Etchegoin *Turritella nova* zone			
Stratigraphic break ?					
		(*Cryptomya californica* zone)		Lower shales in the center and western parts of the basin	
Marine overlap Intermixture of Miocene species	Lower Purisima Bear River "Miocene" Lower Wildcat	Jacalitos *Chione elsmerensis* zone	Jacalitos (Elsmere Canyon) *Chione elsmerensis* zone		

slope (a Pleistocene horse tooth was even found embedded with the marine deposits in the Ventura basin), so that it is now recognized that the diastrophism took place well within the Pleistocene; and (3), as explained below, correlation with the European section shows that the underlying Santa Barbara beds correspond to the uppermost Pliocene of England and Sicily.

The Ventura and Los Angeles basins are keys for the demonstration of the relations of California Pleistocene deposits. The Las Posas zone of the Ventura basin, formerly called basal Saugus, overlying the Santa Barbara zone, has at its base north of the Santa Clara Valley a fossiliferous marine conglomerate or sandstone that represents the littoral phase of a marine overlap. The fauna, in striking contrast to that of the underlying beds, is of a rather warm-water complexion, indicating ocean temperatures at least as warm as those of today and probably warmer, a condition that is to be expected of interglacial ages. The same zone has recently been recognized in the Los Angeles basin, where colder-water faunas occur above it and still higher faunas denoting a return of milder temperatures, all apparently in sequence with the Pliocene, and separated from each other by only minor unconformities. The lower Pleistocene sedimentary cycle is unquestionably of much shorter duration and more limited distribution than either the Miocene cycle or the Pliocene cycle, for the deposits representing it are found only along the present coastal strip and short distances inland in the Ventura basin. The deposits of the end of the cycle, as in the other cycles, are the most limited in extent. Besides the occurrences in the Los Angeles and Ventura basins, the lower Pleistocene is represented by the upper Merced of middle California and possibly by the uppermost part of the Wildcat formation of northern California. These beds are all unconformable below the upper Pleistocene terrace deposits. Non-marine deposits of the same age inland in middle California are known as the Paso Robles, Tulare, and Santa Clara formations.

The land surface that developed while the Pliocene and lower Pleistocene sediments were being laid down has been recognized in a number of places. Presumably its slope was approximately represented oceanward by the plain of aggradation of the top of the marine sediments as originally deposited, and inland by the top of non-marine sediments. The Poway terrace at San Diego, the Perris peneplain in the Los Angeles region, the westward slope of the Sierra Nevada, the mature surfaces of many of the uplifted blocks in the Coast Ranges of middle California, and the Klamath peneplain or one of the younger peneplains recognized by Diller in northern California may all be remnants of the same pre-deformation surface. In southern and middle California the remnants of the pre-deformation surface are bounded by fault scarps of high relief and are in this respect very different from the remnants of the oldest post-deformation surface, which does not seem to have been subsequently much disturbed.

Not until the middle Pleistocene did the great diastrophic revolution take place. It seems, judging from the tremendous structures formed and the unconformities produced, that the post-Miocene movements were insignificant in comparison. In many places thousands of feet of sediments were faulted, upthrust, folded, and sometimes overturned. Rocks from the Mesozoic to the Pleistocene were involved, the youngest beds taking part even in the overturning. The present relief of the Coast Ranges was mostly produced by this revolution.

The time when the revolution began and the duration of its maximum activity are subjects of considerable interest. In the Los Angeles basin we know that it began after the deposition of two cold temperature zones and two milder temperature zones. In the Sierra Nevada the uplift began after the first glaciation was over. If the beginning of the deformation was essentially contemporaneous in the different parts of the state, then the first Sierran glaciation should correspond to the second cold zone of the marine record, that is, the Timms Point zone, formerly called the Deadman Island "Pliocene." As shown below by the independent correlation of the marine section and of the Sierran glaciations with the European divisions, the assumption of contemporaneous deformation in the Sierra Nevada and in the Los Angeles basin is correct. The uplift of the Sierra block may have caused the compression of the coastal belt; or in any case, whatever the cause of the compression, the forces seem to have been so great that all of the basin areas, which are the weak places where the crust is in the habit of making adjustments, were affected. It seems probable that the forces that accomplished this great compressive deformation had been building up for a long time before the storm broke. They may have been responsible during Pliocene and even earlier times for the downpressing of the great sagging arches of the basins of deposition and for the minor unconformities in the sedimentary series. When, however, the total resistance to the horizontal pressures was finally overcome, the forces were released and during a comparatively short period no formation not protected by unusually strong underlying material escaped deformation. For practical purposes the beginning and ending of this main period of folding and overthrusting can be assumed to have taken place at approximately the same time in the various regions throughout California.

California was left with a network system of folded, upthrust, and depressed blocks. The broad terrain of high relief so produced probably extended with about the same character west of the present coast, perhaps nearly to the outer edge of the continental shelf. The western part was probably partly submerged, the higher blocks projecting from the water as islands much as they do today. The shifting of loads caused by the deformation apparently necessitated readjustments of an isostatic nature so that some overloaded blocks began to sink, dragging down small adjacent masses, while others that had been shoved down by lateral pressures were starting to rise. On the rising blocks, like San Clemente Island and San Pedro Hill, a score or so of well-defined wave-cut terraces are found, ranging in height up to 1500 feet. Santa Catalina Island, which lies halfway between San Clemente Island and San Pedro Hill, bears no terraces and is generally thought to have been a sinking block. On the land, some regions exhibit stream terraces, whereas others are drowned in alluvium. That the readjustment was differential is also shown by the fact that waters now standing uniformly at the height of the highest marine terraces would be many feet deep over such inland places as Bakersfield, San Bernardino, etc., and there is no evidence that such an inundation took place in the Pleistocene. The nearly horizontal position of the terraces indicates that the differential uplift took place after the regional compression and folding had ceased.

The readjustments, which took place for the most part along normal faults, were presumably most rapid at first, gradually becoming less and less active. It seems probable that the important part of the differential readjustment, like the main part of the compressive deformation, was accomplished in a comparatively short period, for in various places in southern California an old post-deformation physiographic surface, best represented by the Timber Canyon fanglomerate of the Ventura and Los Angeles basins, was developed, and since the time of its development very little faulting has taken place. Very seldom are the younger marine terraces faulted or deformed in any way except for very broad warping which is usually so gentle that it is not visible to the eye. The submarine relief of the continental shelf shows no obvious features that require very recent, locally differential movements for their explanation, except perhaps the absence of terraces on Catalina Island. The higher terraces on other blocks must have been formed during the time of differential movements, and their absence on Catalina Island can readily be explained by sinking at that time; but the younger terraces of the other blocks, if formed after the time of differential movements, might be expected to appear on Catalina Island. However, their absence, if they are totally absent, may be explained by the scarcity of gentle slopes such as have provided the most favorable places for the cutting and preservation of terraces on San Clemente Island and at San Pedro. Terraces cut in steeper slopes, other factors being equal, are narrower, and after uplift are closer to shore and more likely to be entirely removed by the later work of the ocean. Remnants of terraces on the northeast side of San Clemente Island are infrequent and obscure. Thus the submerged part of the continental border, as described by Lawson,[1] seems to have essentially the same forms as the exposed part, except insofar as the relief has been modified and reduced by more prolonged marine terrace cutting and submarine deposition in the hollows when the sea level was lower than at present.

After the period of differential readjustment was over, the whole western border of the continent seems to have been uplifted gradually as a unit, or the sea level may have subsided eustatically,[2] or both processes may have worked simultaneously. In southern California an old land surface, in many places covered with alluvium, seems to have remained essentially intact, except for erosion, since its formation. The youngest series of marine terraces exposed at various places along the coast from San Diego to Oregon seems to be remarkably uniform in general features, though the individual terraces vary in number and height because of minor local warping.

The outer edge of the youngest marine terrace also varies in height according to the amount the ocean has cut it back, the back slope usually rising to an altitude of 100 or 200 feet, but the outer edge being lower. In places this terrace bears a thin fossiliferous covering. The faunas of the Nester terrace at San Diego and of the Palos Verdes terrace at San Pedro are of distinctly warm-water facies so that these two occurrences can be correlated with moderate confidence; but the fauna in the terrace east and west of Santa Barbara is not essentially different in temperature facies from the fauna living off the coast there today, and hence its correlation with the more southerly terraces must be regarded as somewhat doubtful. The faunas in more northerly occurrences of this or similar terraces are not well known. The correlation of the terrace at Santa Barbara with the Palos Verdes and Nester terraces almost necessarily involves the assumption of a land barrier in late Pleistocene time between Santa Barbara and San Pedro to protect the warm waters of the southern coast from the northern currents, an assumption which additional evidence may be expected at some time to justify.

The youngest terrace (or terraces, if the similar occurrences at the various localities are not to be correlated) contrasts with the older terraces in frequently bearing on its surface deposits containing well-preserved fossils. Fossils have in nearly every case been leached out of the deposits on the older terraces, if indeed the deposits have not been entirely washed away, so that the older terraces can be recognized as marine only by their form and by the presence of Pholad borings in the underlying rock. Also, the topography of the youngest terrace is much younger. The little streams have cut their beds practically to the bottoms of the steep slopes below the older terraces, so that they flow out at grade onto each lower terrace; but they traverse the surface of the youngest terrace in shallow troughs and drop from hanging valleys over the sea cliff. The youngest terrace, however, is not so young as it would appear, for the youthfulness of the remnants that we now see is due to their having been protected by a wide seaward extension of the terrace in past times. We are so used to the steeply shelving coast of California that it is hard to imagine a wide, shallow submarine slope extending far out from the shore in late Pleistocene time, and yet such a condition must have prevailed in most places along the coast, for the ocean had been gradually retreating from its early Pleistocene high level. The bottom of such a gradually retreating ocean should have such a shallow slope.

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[1] Lawson, A. C.: "The Continental Shelf off the Coast of California," Bull. National Research Council, Vol. 8, Pt. 2, pp. 1-23, 1 fig., 1924.

[2] The change of sea level up to 300 feet, more or less, by the withdrawal and return of water to the oceans by glaciation and deglaciation must be considered as a probable alternative to continental uplift and depression. See Daly, R. A.: "Swinging Sealevel of the Ice Age," Bull. Geol. Soc. Amer., Vol. 40, pp. 721-734, 1929.

That the continent[1] as a whole stood higher than at present and that the ocean was for a considerable time during the erosion interval following the cutting of the youngest exposed terrace nearer the continental border than now is shown by the present overdeepened condition of the off-shore areas, by the submerged terrace or terraces developed almost universally on the top of the continental shelf, and by the overdeepened main stream valleys on the land now filled with alluvium. The amount of erosion done at this time by the ocean has not been fully realized. Many large land areas west of the present coast were exposed, cut into, and reduced in extent. It is not unlikely that some of the present islands, at first connected with the mainland, had their connections severed by erosion and drowned by the later submergence. The original outer edge of the youngest terrace of which remnants are now exposed was cut into, and the previous deposits of middle and later Pleistocene as well as of older formations were cut away and carried out partly to fill up the depressed areas on the continental shelf or were removed to the outer slope of the shelf. Later, the ocean returned to cut a higher notch in the youngest exposed terrace, using the material taken from this modern notch to obscure the form of the previous notch. All this time the marine erosion was much more rapid and effective than the work of the little streams along the coast, which were never able to cut down their gradients to the low base level set by the ever advancing shore, and for this reason the thin fossiliferous deposits on the youngest terrace have not been attacked and removed.

In some regions it even seems as if the ocean when returning again to a higher level had risen slightly above its present position, for rivers have filled their valleys with alluvium to somewhat higher levels which they have only very recently cut into. Recent sinking has been noted in the vicinity of San Francisco Bay. It has even been suggested that the returning sea cut the youngest exposed marine terrace described above and left on it its fossiliferous deposits; but in the San Diego and San Pedro regions, and hence probably also in the other regions, the youngest terrace can be seen to be part of the older series, its warm-water fauna containing a few extinct species, and as explained below, belonging to the last interglacial. The recent rising of sea level above its present position cannot have been very great, for if it had been, the youngest exposed marine terrace (the outer edge of which was then farther oceanward than now) would have been overflowed. Possibly the Goleta and Seacliff localities on the Santa Barbara terrace represent such an overflowing, but the presumption is against it. The recent erosion of the alluvial filling of the valleys may be due as much to the shortening of the river profiles by the horizontal cutting of the ocean as to the rising and sinking of sea level. The slight sinking of the land around San Francisco Bay may have been local. The initial flooding of the bay must have taken place when the ocean returned from its low-level stage, after the

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[1] In writing this discussion no attempt was made to distinguish between the sinking of sea level and the rising of the land, or *vice versa*. All that is meant by such statements is a *relative* change of level. The idea of glacial control referred to in the preceding note suggests that the particular change of level referred to here is a change in sea level. This theory would explain the cooler water faunas in the low terraces at Seacliff and Goleta, east and west of Santa Barbara.

Sacramento River had cut the Golden Gate gorge during the time when the ocean was at its low level. The drowned shore line in the bay has been preserved because of the relative impotence of wave action in the bay; but all along the open coast the embayed shore line has been obliterated by the horizontal cutting of the waves, and along the open coast the marine erosion cycle may be described as approaching maturity.

Correlation with the European Standards

The European Section

A comparison of the general features of the California and European sections may lead to a definite establishment of the correlation between them. Articles on the later Tertiary and Quaternary deposits of Europe help to make evident the parallelisms. In the Pliocene, the account given by Harmer of the English Pliocene is most useful,[1] and for the sake of brevity the English Pliocene alone will be considered. In the Pleistocene, Brooks' summary of the vast literature on the northern European Quaternary deposits is unusually good.[2]

It is now generally agreed that there are no Miocene marine deposits in the British Isles. In the earliest Pliocene, however, southeastern England was depressed and the sea transgressed from the northeast over the early Tertiary and older formations, which had just been deformed, during the Miocene, by the peripheral disturbances of the Alpine revolution. Basal conglomerates known as "Boxstones" are found overlying a peneplain or plain of marine denudation in East Anglia and underlying the Coralline and Red Crags. Other beds in a similar position at Lenham carry a more extensive fauna, and this fauna, because of the inclusion of some species more characteristic of the Miocene, has in the past been assigned by several paleontologists to the Miocene. However, a more thorough study of this fauna indicates that it is more closely related to the fauna of the Coralline Crag, and stratigraphic studies have connected the Lenham beds with the Diestien of Flanders, which overlies the Miocene and has always been considered Pliocene by Belgian geologists.

After the deposition of the Lenham beds in the south of England, the region was gradually tilted northeastward and the shore line began a slow retreat that lasted throughout the remaining part of the Pliocene. The Coralline Crag is the first of the zones recognized in the littoral deposits left by the retreating sea. Its fauna is distinctly southern. Most of the species that have survived are found living in the Mediterranean or along the coasts of Portugal and southwestern France. Northern species are very rare. In the next zone recognized, the Red Crag, the southern species began rather quickly to die out, and boreal species began to take their places. This change is attributed by English geologists to the breaking of the direct channel connecting the Anglo-Belgian basin with the south Atlantic and at the same time the exposing of the coast to the colder waters of the northwest. Harmer makes the following remarks:

"As far as the evidence goes, the different fossiliferous zones of the Red Crag do not overlap, occurring in horizontal rather than in vertical sequence. As we trace the northward retreat of the Crag Sea from Walton-on-Naze on the south to Weybourne on the Norfolk coast, we find the various deposits to assume regularly a more recent as well as a more boreal and eventually a sub-arctic character."

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[1] Harmer, F. W.: "The Pliocene Mollusca of Great Britain," Introduction to Volume II, found on pp. 485-505 in Vol. 72 of the Monographs of the Palæontographical Society, December, 1920.

[2] Brooks, C. E. P.: "The Correlation of the Quaternary Deposits of the British Isles with those of the Continent of Europe," Annual Report of the Smithsonian Institution for 1917, pp. 277-375 (Publ. No. 2507), 1919.

Although geographical changes may account partly for this change in thermal facies, they seem hardly adequate to explain why a fauna of south European character should give place to one of sub-arctic character. A more evident explanation lies in the approaching cold of the first glacial age, which, whatever its cause, seems to have been of more than local distribution.

In the upper Pliocene, or Icenian Crag, the basin continued to fill up and the shore line to retreat. Most of the species characteristic of the earlier Crag horizons had disappeared and the fauna had become distinctly arctic and distinctly modern in composition. Because of the filling up of the basin, the waters became slightly brackish in facies, the estuarine *Mya arenaria* being common along with the more normal *Astarte borealis* and other cold-water species. Harmer even suggests that "the advance of the Scandinavian ice may have wholly or partially blocked the northern outlet of the Icenian sea, which may have still received volumes of fresh water (at least in summer) from the rivers of central or southern Europe." A higher horizon is characterized by abundant *Tellina balthica*.

It is interesting to note that in the English type section of the Pliocene there is an extremely cold-water zone at the top, but that no evidence has been found of a corresponding glaciation in the British Isles. Nevertheless, it is now generally agreed that this cold-water marine zone corresponds to the first or Günz glaciation in the Alps. Brooks' correlation of the Cromer forest bed with the Tegelen stage, or first interglacial on the continent, requires also this correlation. Similar cold-water marine beds, characterized by boreal and sub-arctic species are found at the top of the Pliocene in Sicily. It is very unlikely that a mere geographical change could bring arctic species into the Mediterranean. Here, then, lies the explanation of why the Europeans, following Lyell's English section, include the first glaciation in the Pliocene. The discrepancy between the European usage and that of the Americans, who place the beginning of the Pleistocene at the beginning of the first glaciation, was clearly explained by Dr. W. D. Matthew a year ago at a meeting of the Cordilleran Section of the Geological Society of America.

Brooks[1] has correlated the forest bed at Cromer by means of its temperate flora and mixed Pliocene-Pleistocene vertebrate fauna with the well-known deposit at Tegelen in southeastern Holland. Above the forest bed at Cromer lies a stratum of marine sand with an arctic fauna, and a similar bed is known at Yarmouth. These sands are thought to represent the beginning of the second or Mindel glaciation of Europe. True glacial deposits of this age are now recognized in England and referred to as the chalky boulder clay. They are widely distributed and show that the glaciation was more extensive than the later, better known glaciation. The remains of the older deposits, being overridden in many cases by the younger and largely obscured, are difficult to distinguish. Thus the oldest recognized and most extensive glaciation in Great Britain corresponds to the oldest recognized and most extensive glaciation in Holland and north Germany. Toward the end of this age northern Europe was depressed, and the materials of the well-known chief terrace of the Rhine were deposited, and probably also those of the 130-foot terrace of the Thames.

At the beginning of the long interglacial age that followed, the depression of northern Europe continued and the Eem marine beds with a temperate fauna were deposited, forming in places the upper part of the chief terrace of the Rhine. Similar beds occur in Sussex, at Holderness, and other places in England. Everywhere it appears that the submergence was succeeded rather soon afterwards by uplift, and the marine beds gave place to estuarine and lacustrine deposits, the latter characterized by *Corbicula fluminalis, Paludina diluviana,* and *Bithynia tentaculata.* In this interglacial age, which is by far the longest of all, Chellean archæological remains are found in the lower part and Acheulian in the upper.

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[1] *Op. cit.*, p. 311.

The third or Riss glaciation of the Alps is represented by the second glaciation of north Germany, Holland, and England. It is the best known glaciation in England. At Holderness, Yorkshire, and in other places in northeastern England the Hessle boulder clay, belonging to this age, is clearly separated by temperate marine sands from the older chalky boulder clay. This glaciation corresponds to the middle group of terraces along the rivers. The culture was Acheulian, giving place to Mousterian.

The third interglacial is poorly represented except in northern Germany, where it is recognized at Rixdorf and Phoeben, in borings around Berlin, and at several other places. Remains of temperate mammalian species and of mollusca, the chief of which is *Paludina duboisiana,* are found. Most of England seems to have been subjected to erosion, but peat beds at Holderness made up of temperate species are assigned to this horizon. The culture was Mousterian.

The fourth or Würm glaciation is also poorly represented in Great Britain, but it is thought that arctic peat at Holmpton and Pennines in England and arctic peat and small valley glaciers in Scotland represent it. In northern Germany it is well recognized, however, as the third glaciation of that region, and by analogy, the low terraces of the Rhine and other rivers are assigned to it. In Switzerland there was a temporary retreat of the ice in the middle of the Würm glaciation called the Achen interstadial. The culture was Solutrean and at the close early Magdalenian. During the final retreat of the ice there was a slight readvance, known as the Buhlstadium. In Baltic regions this readvance is also recognized, and the period of retreat preceding it is known as the Baltic interstadial.

The retreat of the ice from the southern end of Scandinavia has been carefully studied by De Geer and others in Sweden. By counting the annual varves in the glacial lake deposits, it has been possible to determine with remarkable accuracy the year when the ice edge abandoned each lake, so following the retreat northward. During part of the time, the coasts of northern Europe were slightly submerged and marine deposits are found, first indicating arctic temperatures and then a gradual thermal amelioration culminating in what is known as the climatic optimum. This older *Tapes* or *Littorina* period, as it is called locally in Norway, corresponds to a climatic optimum recognized in nearly all well-known regions of the northern hemisphere. The climate was warm and moist. It was succeeded by a warm dry period, then a cold dry period (sub-boreal period), then a cold wet period (sub-Atlantic period), and finally a somewhat drier period, the present.

Comparison of California and European Sections

The lower Pliocene beds at Elsmere Canyon, the Jacalitos zone, and corresponding occurrences in other parts of California can be correlated with the Boxstones and Lenham beds of England. In both regions these zones contain faunas indicating warm temperatures, including a few species that are more characteristic of the Miocene and that have caused some paleontologists to consider them of Miocene age; but both the faunas are seen to have, when studied in greater detail, a closer relationship with the overlying

TABLE II

CORRELATION BETWEEN CALIFORNIA AND EUROPE

SOUTHERN EUROPE	NORTHERN EUROPE	ENGLAND	CALIFORNIA	GENERAL
	Miscellaneous deposits	Peat (Ireland)	Younger alluvial terraces	Postglacial
Alps: Würm glaciation	(Early Magdalenian culture) Third glaciation (Solutrean culture)	Arctic peat at Holmpton	Third and fourth Sierran glaciations separated by an interstadial	Glaciation
	Rixdorf deposits mammal remains *Paludina duboisiana* (Mousterian culture) Middle group of river terraces	Temperate peat of Holderness	Palos Verdes terrace Older alluvial terraces ? Rancho La Brea vertebrates	Warmer temperatures
Alps: Riss glaciation	(Early Mousterian culture) Second glaciation (Acheulian culture)	Best known English glaciation Hessle bowlder clay	Second Sierran glaciation Continued uplift	Glaciation
	(Early Acheulian culture) Deposits characterized by *Corbicula fluminalis*, *Paludina diluviana*, *etc.* Eem marine beds, temperate fauna (Chellean culture) Chief terrace of the Rhine	Estuarine and lacustrine deposits with *Corbicula fluminalis*, *Paludina diluviana*, *etc.* Sands with temperate fauna of Sussex, Holderness, etc. High terrace of the Thames	Great deformation and erosion truncating deformed beds San Pedro zone	Long interglacial Uplift Marine beds
Alps: Mindel glaciation Sicily: Sicilian	First German and greatest north European glaciation	Maximum glaciation Chalky bowlder clay Arctic marine sands of Cromer and Yarmouth	First Sierran glaciation Timms Point zone	Glaciation
	Tegelen stage	Cromer Forest series	Las Posas zone	Warmer temperatures European division between Pliocene and Pleistocene
Alps: Günz glaciation Sicily: Calabrian	Gravels of the Rhine-Meuse delta	Weybournian, Chillesfordian, Norwich Crag } Icenian	Santa Barbara zone *Mya japonica* zone	Cold temperatures—Pliocene molluscan species killed off American division between Pliocene and Pleistocene
Astien	Amstelien Poederlien Scaldisien Casterlien (*Isocardia cor*)	Butleyan, Newbournian, Waltonian } Red Crag Boytonian, Gedgravian } Coralline Crag	San Diego, Pico, middle Etchegoin zones, Merced, upper Wildcat, etc., etc.	Marine retreat Cold-water species appearing Warm-water species predominant
Plaisancien	Diestien (*Terbratula grandis*)	Lenham beds (*Arca diluvii*) Boxstones	Jacalitos (Elsmere Canyon, etc.) Lower Wildcat, etc.	Marine transgression Warm waters Intermixture of Miocene species

zones of the Pliocene. Also, though this similarity may be but a coincidence, the zones correlated are both the basal phases of marine overlaps on older formations.

It is to be noted here that there is more or less of a break between the Lenham beds and the later Pliocene of England, and that there is a similar break between the Plaisancien and Astien of Italy. If the unconformity suggested by Eaton as occurring in the Ventura basin and elsewhere in California be of importance, it will probably correspond to this break.

The San Diego zone, middle Pico, and corresponding zones in California can be correlated with the Coralline and Red Crag deposits of England, because: (1) they all contain faunas of distinctly warm-water character in the older parts (Coralline Crag), giving place to cold-water faunas at the end (Red Crag); (2) their faunas contain a considerable number of abundant species that are now extinct, but practically all of the species more characteristic of the Miocene have died out; and (3), though it may be a coincidence, they represent a series of littoral deposits left behind by a gradually retreating shore line, the sequence from Fernando Pass to Ventura bearing a striking resemblance to the sequence from Walton-on-Naze to Butley in East Anglia, except that the older part in England, the Coralline Crag, is relatively not quite so extensive as the early San Diegan and occurs only as windows through the later beds.

The Santa Barbara zone of the southern California coastal regions and the *Mya arenaria* variety *japonica* zone of the interior embayment of California can be correlated with the Icenian of East Anglia and the Günzian or first glaciation in Switzerland: (1) by their decidedly cold-water faunas; (2) by the dying out of most of the species characteristic of the older Pliocene horizons so that the faunas become almost Recent in aspect; and (3), perhaps as a coincidence, by their similar position at the end of a sedimentary cycle, the basins filling up and in many places the water becoming somewhat brackish as shown by abundant *Mya arenaria* and species of similar significance. The Icenian and in some places the Santa Barbara zone of California have a different distribution from the preceding deposits, indicating that minor warping had taken place. Thus the Santa Barbara zone should be included with the Icenian as the uppermost zone of the Pliocene according to the European usage, or as the lowermost zone of the Pleistocene according to American usage. Glacial deposits of the Günz glaciation have been recognized in Europe only in Switzerland, and in eastern North America the equivalent Nebraskan has only recently been differentiated. Hence it is not surprising that equivalent glacial deposits have not yet been recognized in the Sierra Nevada.

Of the correlations of Pliocene zones attempted above, that between the Icenian and the Santa Barbara zone seems most secure. Each is marked by a very definite climatic change, by the most important faunal break of the later Cenozoic, a faunal break of much greater magnitude and significance than any of the other faunal changes since the Oligocene, and by the strikingly similar physical relations of the beds. This horizon can be used as a datum plane from which to count the glacial ages upward or the faunal zones downward. It is very encouraging to note that the historical sequences in Europe and in America, both above and below this datum plane, are consistently similar in every essential feature.

It makes very little difference where the boundary between the Pliocene and Pleistocene, between the Tertiary and Quaternary, is placed, so long as the time equivalence of the various zones can be clearly recognized. From a paleontologic point of view it is more logical to place the boundary below the Icenian, and paleontologists of the eastern part of the United States generally favor this view; but from a geologic point of view it is more logical to place the boundary above the Icenian, after the final marine retreat from the English basin and from the San Joaquin basin, and the European precedent favors this view. The course adopted in this paper is the more conservative, involving the least change in the European and Californian usage; hence the Santa Barbara zone and the *Mya japonica* zone are not separated from the formations of which they are the upper members. However, the opposite course would not be in conflict with the correlations made in this paper, and might be more convenient for the consideration of glaciation. The Icenian was the time of the killing off of the old species, but it is doubtful whether many new, distinctly Quaternary species were able to develop before its close. If each writer would make it clear where he draws the Pliocene-Pleistocene boundary, there might be less dispute over the existence of Tertiary man.

The Las Posas zone of the Los Angeles and Ventura basins of southern California can be correlated with the Cromer forest bed of England and with the Tegelen clays of Holland, as well as with the similarly warm temperature Aftonian of eastern North America. The correlation is based on the warm-water faunas, on the scarcity of the extinct invertebrate species in the faunas, and on the stratigraphic position of each immediately above the uppermost Pliocene zone and immediately below the next cold-water zone. The Cromer forest bed is sometimes included in the Pliocene along with the Icenian, possibly because the cold of the first glaciation was not severe enough to exterminate the last Pliocene vertebrates; but stratigraphically and paleontologically it does not seem to be a logical arrangement either in Europe or in California. The compromise position is taken here of putting the Santa Barbara zone or Icenian in the Pliocene, and the Las Posas zone or the Cromer forest bed, the first interglacial, in the Pleistocene, making the division at the end of the Pliocene sedimentary cycle and before the beginning in California of the lower Pleistocene sedimentary cycle.

The cold-water Deadman Island "Pliocene" or Timms Point zone, overlying the Las Posas zone, can be correlated with the Mindelian or second glaciation of Europe, with the arctic marine sands at Cromer and Yarmouth, England, and with the chalky boulder clay by means of its cold facies and stratigraphic position. The oldest recognized glaciation of the Sierra Nevada, antedating the great uplift, can also be shown to belong to this age by comparing the various glaciations of the Sierra Nevada and of Europe and counting from the last backwards. The California marine section calls for two glacial ages before the deformation and uplift, and as there is only one recognized in the Sierra Nevada, it is much more likely to be the Mindel, corresponding to the greatest glaciation of Europe than it is to be the Günz, which has been recognized only under the most favorable conditions and probably was only developed in the coldest places. The Sierra Nevada before the great uplift, situated as it is in comparatively low latitudes, probably was not an unusually cold region.

The typical San Pedro zone of the San Pedro formation, with a fauna not so cool as that of the Timms Point zone and possibly containing in places, as at Signal Hill (Los Cerritos) and in the Baldwin Hills, Los Angeles County, California, comparatively warm-water phases, can be correlated by its stratigraphic position and thermal facies with the lower part of the long second interglacial of Europe represented by the Eem beds or *Paludina diluviana* zone on the continent, and in England by the marine beds of Holderness, Yorkshire, etc. At some time after the beginning of this long interglacial age, uplift of some sort seems to have been nearly universal. In Switzerland the Alps were uplifted; in northern Germany, Holland, and England the marine beds gave place to continental; in the Sierra Nevada the uplift took place early enough so that the rivers could cut 2000-foot canyons below the moraines of the first glaciation before the beginning of the second; and in the Coast Ranges of California came the mid-Pleistocene diastrophic revolution already dwelt upon, followed by or accompanied by uplift. Whether all of these apparently contemporaneous uplifts are related or not is still a matter of conjecture, but it now seems probable that the deformation of the various regions in California is a single phenomenon.

The second glaciation of the Sierra Nevada corresponds in character and in sequence with the second glaciation of north Germany, Holland, and England, and with the Rissian or third glaciation of Switzerland. As in Great Britain, it is much more extensive than the last glaciation. It may have been made stronger relative to the first by the uplifts, but not enough is yet known of the extent of the first to make comparisons possible. Although the principal part of the uplift may have been completed by this time, the erosion probably was not. The valley gorges of the Sierra must have been deepened more rapidly during this glaciation; but the stream erosion apparently continued throughout the next interglacial, entirely obliterating the earlier glacial forms of the valleys. The remains of this glaciation are found only in isolated patches perched high above the present canyon bottoms.

Along the coast the continued uplift must have caused the cutting of some of the oldest marine terraces; and, if so, the lack of deformation of these terraces shows that the compressive forces causing the deformation had already spent themselves. The differential readjustments among the smaller blocks must also have been accomplished before the formation of the older alluvium terraces and the Rancho La Brea asphalt deposits. According to the correlations here attempted the earliest possible time when the Rancho La Brea deposits could have been formed is at the end of the long Mindel-Riss interglacial age. Furthermore, in order to imagine their accumulation at that time, it is necessary to suppose that the deformation of the underlying beds and the planing off of the edges of these deformed beds had been accomplished, and that conditions of erosion had given place to conditions of deposition allowing the accumulation of alluvium to hold the asphalt that seeped up through a fracture zone in the crest of a planed-off anticline in the deformed beds below, and to suppose that all these events took place in a single interglacial age. Obviously it is crowding the stratigraphic evidence considerably, and confining the period of differential movements into an unusually short time, to consider that all of these events took place within a single interglacial age, even though there is clear evidence that this interglacial age is much longer than any of the others.

The famous Rancho La Brea vertebrate fauna has in the past been considered much older, has been repeatedly called lower Pleistocene;[1] and in deference to these opinions it was first placed in the accompanying correlation table at the end of the Mindel-Riss interglacial, late middle Pleistocene, giving it the greatest age that the correlations would allow. It truly seems from the large number of extinct vertebrates (about half of the species in a rather large fauna) that the evidence for its antiquity is strong; but as in the more recent opinion of Dr. Chester Stock of the California Institute of Technology the vertebrates do not give conclusive evidence that the deposit is older than upper Pleistocene, and as the present paper is based chiefly on other kinds of evidence, it seems best to assign the Rancho La Brea asphalt lake and the older alluvium terrace deposits, which seem to be contemporaneous, to the part of the geologic column in which the other kinds of evidence indicate that they would fit the best.

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[1] Osborn, H. F.: "Mammals and Birds of the California Tar Pools," Natural History, N. Y., Vol. 25, pp. 527-543, 1925.

Assuredly the processes of deformation, erosion, and subsequent isostatic readjustment among the local crustal blocks, all of which apparently preceded the time of the general accumulation of alluvium in California, are processes requiring a considerable amount of time for their completion. It seems improbable that they could have been completed by the end of the Mindel-Riss interglacial; and therefore it might be well to consider if there is any more likely time for the deposition of the alluvial terrace deposits. The widespread deposition of alluvium indicates depression. The weight of glacial ice is known to have had some effect in depressing continental areas, and investigations of the effects of the most recent glaciation in Scandinavia and in eastern North America have shown that after the return of the glacial waters to the oceans there has been a certain amount of lag in the recovery of the continental areas. Hence the time when the continent was downpressed and the oceans full would be the most likely time for a temporary reversal of movement in a region that was being subjected to gradual uplift, and such a time is the end of a glacial age. It is interesting to note that Brooks correlates the terraces of the Rhine, the Thames, and other European rivers (in some of which fossiliferous deposits have been studied) with the ends of glacial ages and the beginnings of interglacial ages. As the climatic indicators of the Rancho La Brea fauna are conflicting, the mammals pointing to cold temperatures and the birds to warm, it would not be unreasonable to suppose that the accumulation of the vertebrate remains continued from the end of the glacial age into the beginning of the succeeding interglacial, that many of the animals may have migrated northward while the birds were arriving from the south. Obviously, there is but one place in the correlation table where such conditions are indicated and where the Rancho La Brea fauna and the older alluvium deposits can be placed, the end of the Riss glaciation. It can be further pointed out that after the mid-Pleistocene deformation there have been but two glaciations, and in the various regions of southern California there are but two well-defined sets of alluvial terrace deposits, the younger having an admittedly Recent, postglacial, appearance.

The Riss-Würm interglacial seems to be an age of continued uplift in California and of local uplift in Europe. European deposits are scarce and non-marine. In the Sierra Nevada the cutting of the inner valleys was continued. Along the coast, marine terraces were developed with remarkable uniformity from San Diego, perhaps from Lower California, to Oregon or farther. The Palos Verdes terrace at San Pedro in the Los Angeles basin and its equivalents along other parts of the coast provide one more definite horizon for correlation. Marine deposits well described by Arnold as the upper San Pedro series indicate that the ocean temperatures were considerably warmer than at present and require that these deposits be assigned to the only interglacial age not already accounted for, that is, the Riss-Würm, or last interglacial. For physiographic and other reasons these deposits are too old to be assigned to the post-glacial climatic optimum which has been dated by Scandinavian geologists as reaching its maximum in about the year 4100 B. C. In the Palos Verdes deposits there may be one or two important extinct invertebrate species (*Cancellaria tritonidea*, *Cantharus fortis*), and remains of vertebrates belonging to the Rancho La Brea fauna have not infrequently been found. As it is unlikely that so many fossil bones could stand transportation and deposition unless fresh, this latter fact is taken as confirmation of the correlation of the Rancho La Brea fauna with the beginning of this same interglacial age. Furthermore, Dr. Stock states that overlying the terrace at Santa Barbara, which as shown above must also be assigned to this interglacial age and may be the exact equivalent of the Palos Verdes, is an asphalt deposit (near Carpinteria) that has yielded remains of some of the Rancho La Brea species. This last deposit must be appreciably younger than the terrace, for time must be allowed for the withdrawal of the sea and the accumulation of the asphalt, but there is nothing in the physical relations to show how much younger it may be. The vertebrates may not have been entrapped until after the last glaciation had begun.

The last glaciation saw the ocean nearer the outer edge of the continental shelf, eroding away the broad westward extension of the Palos Verdes terrace, cutting lower terraces that are now submerged, removing the portions of the continental shelf that had been elevated above the general level, and filling in the hollows with the detritus. At the same time the so-called third and fourth glaciations of the Sierra Nevada were taking place.

The third and fourth glaciations of the Sierra Nevada are very closely related to each other, being separated only by a comparatively brief retreat, both belonging probably to the fourth or Würm glaciation of Switzerland. It is to be noted that a similar brief retreat of the ice took place in the Alps near the middle of the Würm glaciation, and that in eastern North America the earlier part is called a separate glaciation, the Iowan, although it is recognized to be closely related to the later or Wisconsin glaciation. The Alpine retreat is known as the Achen interstadial. During the final retreat of the ice in Europe, several slight readvances took place, the Buhl, Gschnitz, and Daun stadia. It is possible that these or other readvances can be recognized in the divisions of the Wisconsin glaciation of eastern North America, but it is unlikely that they should be represented so far south as the Sierra Nevada. The third and fourth Sierran glaciations are much smaller than the second, the fourth being distinctly less than the third. As hitherto only this last pair has been recognized, it can be understood why LeConte, who made most of his study in the Sierra, should have concluded that there was a long division of the Pleistocene preceding the glacial. He has been recently quoted to this effect by Eaton.

In the final stages of the ice retreat there occurred in northern Europe minor submergence of the continental borders, upon which were deposited marine shell zones indicating at first arctic conditions, later succeeded by less severe and finally by decidedly warm conditions. The same succession is recognized in the peat bogs of various regions; and the time of warmest temperatures, warmer than today, is known as the climatic optimum. So far as known, there is but one time since the last glaciation when the general temperatures were warmer than at present; and if this horizon could be recognized in California, one more reliable datum plane would be furnished for the post-glacial. So far, this has not been done. Perhaps archeologists have recognized this horizon in their work in Arizona and New Mexico. The annual rings of a single living big tree in the Sierra Nevada should reach two-thirds of the distance back to the climatic optimum, for in Antevs' most recent chronology the climatic optimum is dated as having reached its maximum 6000 years ago (0 taken as A. D. 1900). Owens Lake, in eastern California, has been estimated to have overflowed last about 4000 years ago.[1] Of the post-glacial geologic history of the coast of California we know only that the ocean returned or had returned to approximately its present level, that it may have risen slightly for a brief time during the deposition of the younger alluvial terraces and afterwards sub-

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[1] Gale, H. S.: "Salines in the Owens, Searles, and Panamint Basins, Southeastern California," U. S. Geol. Survey, Bull. 580-L, pp. 251-323, 1914, see especially pp. 263 and 319.

TABLE III

CORRELATION OF GLACIAL AGES

Years		California Marine	Sierra Nevada	Eastern States	Northern Europe	Switzerland
Estimated duration of each age	Total time since beginning of each age	? Recent sinking of San Francisco and San Diego bays	Postglacial erosion		Various deposits indicating intermediate temperatures	
	(6,000)	?		Climatic optimum	Climatic optimum	Climatic optimum
18,500	18,500	? Small uplift ? Younger alluvium			Various deposits indicating intermediate temperatures	
4,000	22,500	Regional depression		Late Wisconsin	Buhlstadium	Buhlstadium
				Temporary retreat	Baltic interstadial	
?12,500	35,000	Ocean at continental border	Fourth glaciation	Early Wisconsin	Third German glaciation	Later Würmian
?20,000	55,000		Temporary retreat	Temporary retreat		Achen interstadial
?20,000	75,000	? Carpinteria vertebrates	Third glaciation	Iowan		Early Würmian
75,000	150,000	Regional uplift Palos Verdes Regional uplift ? Rancho La Brea—older alluvium	Continued uplift ? Temporary depression	Sangamon interglacial	*Paludina duboisiana* zone	Riss-Würm interglacial
? 40,000	190,000	Formation of early terraces Differential uplift	Second glaciation (Valley erosion ⅔ completed)	Illinoian	Second German and best known English glaciation	Rissian
240,000	430,000	Deformation and erosion truncating deformed beds	Beginning of uplift	Yarmouth interglacial	*Paludina diluviana* zone Eem marine beds	Mindel-Riss interglacial (Uplift)
		San Pedro zone				
? 50,000	480,000	Timms Point zone	First glaciation	Kansan	First German glaciation	Mindelian
? 80,000	560,000	Las Posas zone		Aftonian interglacial	Tegelen clays	Günz-Mindel interglacial
? 40,000	600,000	Santa Barbara zone (Pliocene)		Nebraskan	Icenian (Pliocene)	Günzian

sided, and that the time since the return of the ocean from the low-level stage has sufficed to develop a nearly mature shore line along the drowned coast, except in San Francisco Bay where the shores are protected from the wave action of the open ocean.

The estimations of the duration of the various glacial and interglacial ages shown in the accompanying table are for the most part hypothetical and only roughly relative. They are based upon Penck and Brückner's estimation of the relative amounts of weathering undergone by the various glacial moraines during each succeeding interglacial age, taking the post-glacial as a unit. The post-glacial has been accurately measured by De Geer in Scandinavia, who counted the annual varves deposited in glacial lakes and the similar clay layers in post-glacial fiords. Antevs has given a recent summary of the geochronology of the period since the retreat of the ice from southern Scandinavia.[1] It is calculated that the ice retreated from southern Sweden about 13,500 years ago and took about 5,000 years to retreat northward, making the post-glacial in northern Sweden only 8,500 years long. At a similar rate it would have taken the ice about 5,000 years to retreat across the Baltic, which means a total of about 18,500 years for the post-Buhl period, corresponding fairly closely to the 16,000 years estimated by Penck and Brückner from the rate of accumulation of deltas in northern Europe. The Buhl-stadium is estimated as another 4,000 years, which gives a unit of 22,500 years for the post-Würm period in central Germany.

The Günz-Mindel interglacial is calculated as three times as long as the post-glacial; and the Mindel-Riss, which was very long, as twelve times. The figures for the glacial ages are mere guesses, compromises between the opinions expressed by various authors. There may have been numerous withdrawals and readvances of the ice and even whole glacial ages, especially before the Riss and Mindel, that have everywhere been entirely obscured by later more extensive glaciations. In relatively warmer regions, perhaps in the Sierra Nevada, the interglacials must have lasted proportionately longer than is indicated in the table, whereas in colder regions (like Greenland today, for instance) they must have been proportionately shorter. However, it is hoped that the estimates will help to give a better perspective to the Pleistocene history.

The application of the figures, however rough, may be of some use in giving an approximate idea of the rate at which geologic and evolutionary processes proceed. For instance, they may indicate that marine erosion can reduce an embayed shore line in such rocks as occur along the coast of California to a state approaching maturity within a period of about 20,000 years. However, great caution in drawing such conclusions is advisable. The Rancho La Brea fauna, with all its extinct vertebrate species, appears to be only about 150,000 years old. Whether the La Brea fauna be assigned to the second or to the third interglacial age, it is a mystery inviting speculation why so many species should live through two or three glacial ages and be exterminated in the last.[2]

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[1] Antevs, E.: "On the Late-Glacial and Post-Glacial History of the Baltic," Geographical Review, Vol. 12, pp. 602-612, 1922.

[2] Since this paper was written a very important series of articles in the form of a symposium on the glacial theory has appeared in the Bulletin of the Geological Society of America, Vol. 40, no. 4, December 31, 1929. The late Cenozoic deformation has been recognized in the Andes by E. W. Berry in an abstract of a paper published in the Journal of the Washington Academy of Sciences, Vol. 20, pp. 69-70, 1930; and a paper by H. Suter in the Centralblatt für Mineralogie . . . , pp. 269-277, 1927, is stated by G. Steinmann in his "Geologie von Perú," p. 254, 1929, to have correlated the ice ages of the Andes with the Mediterranean and the Alps. Another pertinent article, "Correlation of Coastal Terraces" by C. W. Cooke, has been published in the Journal of Geology, Vol. 38, pp. 577-589, 1930. Perhaps the most plausible explanation of the cause of glaciation is suggested in H. T. Stetson's article on "Cosmic Clouds" in the Scientific Monthly, pp. 217-224, September, 1930.

Also, since this discussion was written, another, very important work has appeared,—Matthes' "Geologic History of the Yosemite Valley," U. S. Geological Survey, Professional Paper 160, 1930. Matthes mentions (p. 75) some uncertainty in the correlation of the glacial stages of the Yosemite with the stages worked out by Blackwelder on the eastern slope of the Sierra. Obviously, the following attempt to reconcile the history of the Yosemite with the outline of events given in this paper can only be tentative. The development of the broad-valley physiographic stage seems to have begun after the minor Coast Range deformation and the tilting of the Sierra block at the end of the Miocene. It may have proceeded, with various interruptions or set-backs caused by slight renewals of the tilting movements, through a

Concluding Remarks

It is hoped that the outline given above will make it evident that the available record of the later Cenozoic history of California is one of the most interesting and most instructive chapters in the geologic history of the earth. Many of the sedimentary formations, geologic structures, and physiographic surfaces of California are so young and so well exposed that they can be looked upon almost as huge laboratory experiments in sedimentation, mountain-building, and stratigraphy. Sediments recently deformed and uplifted to places where they can be observed offer opportunities for study that rival the opportunities for studying submarine processes in the present oceans, and in addition illustrate the effects brought about by the geologic processes of deformation and erosion on bodies of such materials. Mountains that were formed but yesterday make much the best subjects for studying orogeny. The readjustments that can be seen to have taken place subsequent to the main period of orogeny have an important bearing on the application of the theory of isostasy. Of fully as much interest are the remnants of ancient physiographic forms, many of them strikingly fresh and well representative of the surfaces to which they once belonged; and these physiographic forms become especially important when it is recognized that an understanding of them is necessary for a satisfactory working out of the history of the region and a proper estimation of the significance of the other phenomena.

The field of study aiming to bring out the interrelations among the various geologic phenomena of sedimentation, deformation, and erosion, with a quantitative estimate of their age, duration, and magnitude has hardly been touched upon. Pioneer geologists came to California with conceptions based upon the entirely dissimilar conditions of Atlantic regions; and although by taking broad views of the country they were able to recognize many of the important relationships, for which they deserve the highest credit, they did not have sufficient facts at the time to be able to see, in what is now believed to be the proper perspective, the events that have taken place in late geologic time. Later geologists have been busy collecting the facts which are necessary for a comprehensive understanding of the history of the region and for making improvements on the views of the pioneers; but, partly because of the prevailing theory of diversity,

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considerable part of Pliocene time, through perhaps several million years. Then it appears that minor movements such as preceded the deposition of the Santa Barbara zone along the coast were represented by more tilting of the Sierra block, inaugurating the development of the mountain-valley stage. The mountain-valley stage developed during the Günz glaciation (not yet recognized in the Sierra), during the first interglacial, during the Mindel glaciation (recognized on the eastern slopes but not in the Yosemite), and perhaps during the early part of the second interglacial, in all some 200,000 years or more. The profile of the Merced River was cut down about 900 feet. Then came the Pleistocene diastrophic revolution, accompanied by much greater tilting of the Sierra block, which inaugurated the cutting of the canyon stage. This lasted probably through most of the long second interglacial, through the Riss glaciation (what is here called the second glaciation of the Sierra, probably the Glacier Point stage of Matthes), and through the last interglacial, in all about 300,000 years or more. The profile of the Merced River was cut down about 1,200 feet, the stream-cutting being assisted probably by the glaciation of the Glacier Point stage. Then came the El Portal stage of glaciation, which seems to correspond to what is here called the third glaciation of the Sierra and perhaps to the Iowan glaciation of the eastern states and the early Würm of Europe. According to the correlation table, it ended only about 55,000 years ago. Matthes gives good evidence that the succeeding period must have been of considerable duration, but in comparison with the other interglacials it seems to have been short and it may be admissible to call it an interstadial. The stream erosion accomplished during the interval seems to have been very small (Matthes, p. 67). The last or Wisconsin stage of glaciation may have lingered in the Yosemite region until even less than 10,000 years ago, to judge by the freshness of some of the glaciated surfaces. The evidence of two advances during this stage (Matthes, p. 60) suggests that the last maximum may represent the Buhlstadium, the ice at the heads of the glaciers not disappearing until much later. There are even now some small remnants in some of the northeasterly facing cirques.

The rate of stream erosion postulated above for the mountain-valley and canyon stages does not seem unreasonable, when it is considered that in the former stage the erosion was working on deeply-weathered materials and that in the latter it was assisted by a much-steepened gradient and by the glaciation of the Glacier Point stage. It is probable that during the development of the broad-valley stage several mountain valley forms had been produced and subsequently obliterated beyond any present possibility of recognition. The evidence given by Matthes (pp. 70-73) of the antiquity of the El Portal stage is a much more serious difficulty. If the El Portal ice retreated 55,000 years ago and the Wisconsin ice 10,000 years ago, the glaciated surfaces of the former would have been subjected to weathering only five and a half times as long. For the obliteration of glacial polish on rock surfaces that length of time would, perhaps, be enough, especially as the polish of the last stage has in many places already been obliterated (p. 69). But the pedestals and the aplite dikes cited by Matthes suggest that even with a more severe climate during part of the time (during the later glacial stage), the estimated time would be too short. It is probable that the estimates should be revised upward.

little has been done toward organizing the local facts that apply to the various more or less isolated districts with a view to fitting them into a related whole. Recently a few writers have taken pains to state that the forces affecting the surface of the earth are so diverse and are so local in their effects that it is practically useless to attempt to visualize the history of a whole region as a unit, and still more futile to attempt interregional correlations.

And yet it now seems that the study of such problems is already possible. The foregoing discussion is intended to show, if it does nothing else, that a beginning can even now be made. Even if the conclusions hereby arrived at are later partly disproved, it is believed that the additional facts brought out to disprove them will merely make the newer views more accurate and that the possibility of making rough correlations and of working out a regional history will not again be questioned. It is hoped that, as far as the later Cenozoic history of California is concerned, the period when geologists could imagine unlimited time and unlimited forces of any nature without regard for the dates and forces recognized in neighboring districts is now passing. There is diversity, of course, diversity in details; but the major movements of the earth's crust seem to have remarkably widespread effects, and their wide distribution should not be denied merely because a satisfactory explanation is not yet found.

The correlations proposed above and the outlines of the geologic history of the various regions considered are now offered as a basis for discussion. It is hoped that they will be corrected and improved upon by other workers.

HOYT RODNEY GALE.

Los Angeles, California
January, 1930

PART II

SYSTEMATIC PALEONTOLOGY

PART II

SYSTEMATIC PALEONTOLOGY

Introduction

The Mechanics and Accomplishments of Paleontologic Study

The study of paleontology has some features in common with open pit mining. A certain amount of work must be done with no direct gain before the material sought can be reached. A certain amount of worthless material must be shoveled up and carted away before the coal or diamonds or other valuable deposit is exposed to be worked. The object of the study of paleontology or of conchology or of any other kind of investigation of organic beings is to discover the natures of the various organisms and the relations between them. But before such a study can be carried on successfully, all sorts of incidental problems of no real value in themselves must be settled and got out of the way. In the case of conchological paleontology, the most vexatious part of this worthless overburden is nomenclature and the problems connected with it, which are bound up in ambiguous passages and interpretations of sometimes rare but only moderately ancient writings and in the stupendous voluminousness of modern literature. Difficulties in collecting specimens, of handling them in the laboratory, of examining them under microscopes or under the naked eye, and other physical mechanics are expectable and bearable; but the burden of mastering the literature and of settling nomenclatorial problems is becoming so great that it usurps the larger part of an investigator's time; and unless he watch himself, he will find himself devoting his entire time to it, never reaching the starting point of real accomplishment. Too much work is done merely in the literature, making more literature out of old literature; too little attention is paid to actual specimens and almost none to large aggregates of specimens considered in the light of living beings. So much effort is expended on the literature that not enough is left to overcome the normal mechanical difficulties of collecting and handling specimens, and as a result the latter are sadly neglected. It is as if the overburden had become so great that many pits never reach the valuable deposit through it and in many of them the hole is so small at the bottom that production is confined to a very narrow, limited spot. A thimbleful in the top of the deposit is all that is taken out. The man of large enterprises, who is accustomed to remove mountains with steam shovels, looks once at these paltry details of accomplishment and turns elsewhere for more profitable fields of endeavor. So would the Lamarcks and Linnæuses of today turn away from systematic conchology and paleontology and devote themselves to physics, medicine, politics, philosophy, business, or in any case to some field where the overburden is at present not abnormally thick.

It is hoped for the sake of the conchologist and paleontologist that the present conditions are abnormal. We are in a state of transition from the old system of nomenclatorial natural selection to the new nomenclature according to fixed rules. Formerly, prior publication was a powerful argument in favor of a name, but the work of a genius like Lamarck was not set aside for a sales catalogue without descriptions because the latter had one year's priority. In other words, priority was like brute strength in the animal kingdom and usually prevailed according to the workings of natural selection, but cunning in the one case or wisdom in the other sometimes prevailed and it was hoped that in the end reason would have full sway in both. Now, instead of natural selection, we have an International Commission on Zoological Nomenclature, and we attempt to regulate nomenclature by arbitrary fixed laws. That unexpected and unimaginable difficulties should have arisen in the application of such fixed laws is not surprising, for experience in many fields shows that government by fixed laws has always met with difficulties and in very few cases, if ever, has it succeeded permanently, until the laws themselves could be made adaptable to evolutionary change. Although at present there is less uniformity in usage than at the beginning of the century, so many changes in names having been made recently and so many still being made, it is possible that scientists may in the long run be able to furnish an exception to the general rule against government by fixed laws, and it is to be hoped that their present experiment will finally succeed. In any case, we can feel sure that eventually the transitional period will end. Either there will be a return to natural selection, so that the nomenclature will again be determined by custom and by a preponderance of opinion among the leaders or geniuses of the profession; or there will be a rigid adherence to the rules of the International Commission and the petty proposers of names will be enthroned, at least for a time, with later, perhaps, a gradual modification of the rules so as not to limit the progress of science. Obviously, uniform usage should be the chief aim of the systematist; and although it might be a matter of opinion which way uniformity can be more easily attained and which way would bring with it less disagreeable features, it is clear that all workers should follow the same plan. At present, the concensus of opinion is strongly in favor of abiding strictly by the rules, and consequently the present writers are doing their part to upset usages and change names to the end that eventually uniformity may be reached. We must play the game, even though it is at times disheartening to see familiar names give place to obscure substitutes.

Nomenclature

In a number of cases when the time and necessary materials were available, the present writers have attempted to follow a systematic procedure for determining the proper nomenclature. They believe that following this procedure, or something very similar to it, is the only satisfactory method of settling nomenclatorial problems. It has become manifestly unsafe to accept without verification the dictates of nomenclatorial autocrats, unless it be clearly recognized that the unverified usages are merely makeshift, temporary arrangements. The International Rules or Code of Zoological Nomenclature and the opinions interpreting these rules issued by the International Commission on Zoological Nomenclature must be carefully studied by every worker and must be rigidly adhered to, if our present experiment is to succeed in bringing us appreciably nearer uniformity.[1]

Generic names, including names of genera, subgenera, and sections, and specific names, including names of species, subspecies, and varieties, are treated in nearly the same manner. Names of both classes depend upon priority, the first name validly published since January 1, 1758, taking precedence. Also, in both classes, the names are anchored to a definite part of the animal kingdom by types, the generic by type species and the specific by type specimens (if preserved). The method of proceeding is as follows:

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[1] The International Rules were published in the Proceedings of the Ninth International Congress on Zoology held at Monaco, March, 1913. The opinions, now over a hundred, have been published from time to time by the Smithsonian Institution as miscellaneous publications (Nos. 1938, 1989, 2013, 2060, 2169, 2256, 2359, 2409, 2657, 2747, 2830, 2873, 2973, 3016), the more recent of these numbers being kept together in Volume 73 of the Miscellaneous Collection. In order to make this material more accessible, the rules and summaries of the first ninety opinions were republished in the Proceedings of the Biological Society of Washington, Vol. 39, pp. 75-104, July 30, 1926.

In the case of generic names, a list is made of all the names that have been applied to the family, or the part of the family under particular consideration, in the order of the dates of earliest publication. Then each name is considered, beginning with the oldest, first to determine if it is available, that is, actually published after January 1, 1758, in a form consistent with the binomial system (or in a binary sense as described technically in the opinions of the International Commission), and not previously used in any other sense in such a way as to invalidate it as a homonym, and afterwards to determine to what part of the family it is anchored by its type species.

The determination of the type species is sometimes difficult. If the type is specifically designated in the original description of the genus (type by original designation),[1] or if but one species is mentioned in the original description (type by monotypy), or if one species cited in the original description has a specific name exactly like the proposed generic name or has in its synonymy a *specific* name exactly like the proposed generic name (type by absolute tautonymy), the type is thereby definitely fixed and the task is easy. But if the type is not definitely determined by the text of the original description, its designation must be sought in the writings of subsequent authors (type by subsequent designation). The author must actually use the word *type* (or its equivalent in a foreign language) to make the designation valid. In the few cases in which generic names have been proposed without species, the first author who assigned species to them should be treated as if he were the original describer, insofar as type designation is concerned. In all cases of type by subsequent designation it is essential to know what species[2] were included in the genus by the original describer or by the one who first assigned species to the genus, for only such species are available as types, and designations of other species are not valid, not even designations of recognized synonyms of species in the original list (unless they are technically exact synonyms, based on the same type specimens, such as names published as *new names for* species in the original list). In the case of generic names definitely proposed as substitutes for older names preoccupied, it is assumed that the new name must take the type that the old name would have had according to the ordinary methods of fixing the type; but the present writers believe that if the invalid name is merely listed in the synonymy of the new name, it not being expressly stated that the latter is a *new name for* the former, then the type may be selected either from the list of species cited in the description of the new genus name or from the list of species cited in the original description of the old name referred to (and clearly meant to be included by the author of the new name), according to the ordinary processes of type fixing.[3]

Some of the works in which type designations for molluscan genera are most apt to be found are:

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[1] This includes not only cases where the author states definitely that a certain species is the type, or the genus is typified by a certain species, but also where an author names a new species or renames an old species "*typus*" or "*typicus*" as a specific name (Int. Rules, Art. 30, I, b).

[2] These species include synonyms mentioned at the time but no synonyms or species referred to questionably.

[3] For further discussion see pp. 486-487, 512-513, 602-603, 604, 609-610.

Montfort, Denys de: "Conchyliologie Systematique . . .," Paris, 1810, chiefly gastropods and cephalopods.

*Schumacher, C. F.: "Essai d'un Nouveau Système des Habitations des Vers Testaces," 1817. Until the publication of Stewart's paper (1930, listed below), the present writers considered as valid type designations only the passages in which Schumacher actually applied the word *type* to the species cited under a genus. However, Stewart has pointed out that a sentence in Schumacher's Introduction (p. 20) may make a validly designated type of each species cited under a genus in which Schumacher had but one section, for in that case there is but one species under the genus and it appears that Schumacher definitely designated as types the species he cited. As in other cases in which Stewart has discovered authors designating types that the present writers did not know of in preparing this catalogue, the reference is preceded by an asterisk (*).

*Schmidt, F. C.: "Versuch über die beste Einrichtung . . . der verschieden Naturkörper . . . , vorzüglich der Conchylien-Sammlungen, . . ." etc., (Gotha), 1818.

*Fleming, J.: Article on Conchology in the Supplement to the Encyclopædia Britannica, (Edinburgh ?), 1818-19.

Fleming, J.: Article on Mollusca in the first American edition of the Edinburgh Encyclopædea, Philadelphia, 1821.

Children, J. G.: "Lamarck's Genera of Shells," Quarterly Journal of Science, Literature, and the Arts, Vol. 14, pp. 64-86, Oct., 1822; pp. 298-322, Jan., 1823; Vol. 15, pp. 23-52, Apr., 1823; pp. 216-258, July, 1823; Vol. 16, pp. 49-79, Oct., 1823; pp. 241-264, Jan., 1824.

Fleming, J.: "Molluscous Animals, including Shell Fish; . . ." forming the article "Mollusca" in the Seventh Edition of the Encyclopædia Britannica, (Edinburgh), 1837.

*Anton, H. E.: "Verzeichniss der Conchylien," 1838-9.

Herrmannsen, A. N.: "Indicis Generum Malakozoorum," Vol. 1 (A-L), 1846-47; Vol. 2 (M-Z), 1847-49; Supplement, 1852.

Gray, J. E.: "A List of the Genera of Recent Mollusca, their Synonyma and Types," Proceedings of the Zoological Society of London (Pt. 15) for 1847, pp. 129-219, November, 1847.

Woodward, S. P.: "A Manual of the Mollusca," Ed. 1, 1851-56; Ed. 2 (with additions), 1866-68; Supplement to Ed. 2 and Ed. 3, by Tate, R., 1869, 1875.

Meek, F. B.: "A Report on the Invertebrate Cretaceous and Tertiary Fossils of the Upper Missouri Country," Hayden Report, U. S. Geological Survey of the Territories, Vol. 9, 1876.

Stoliczka, F.: Memoirs of the Geological Survey of India, Paleontologia Indica, Ser. 5, Vol. 2, (Gastropoda), 1867-68; Ser. 6, Vol. 3 (Pelecypoda), 1870-71.

Bucquoy, E., Dautzenberg, Ph., and Dollfus, G.: "Mollusques Marins du Roussillon," Vol. 1 (Gastropoda), 1882-1886; Vol. 2 (Pelecypoda), 1887-1898.

Cossmann, A. E. M.: Various writings, especially in the series: "Catalogue des Coquilles Fossiles de l'Éocène des Environs de Paris," Annales de la Société Royale Malacologique de Belgique, Vol. 21, pp. 17-186, pls. 1-8, 1886; Vol. 22, pp. 3-214, pls. 1-8, 1887; Vol. 23, pp. 3-324, pls. 1-12, 1888; Vol. 24, pp. 3-380, pls. 1-12, 1889; Vol. 26, pp. 3-163 (Supplement), pls. 1-3, 1891; Vol. 28, pp. 3-18 (Appendix No. 1), 1893; Vol. 31, pp. 3-94 (Appendix No. 2), 1896; Vol. 36, pp. 9-110 (Appendix No. 3), pls. 1-7, 1902; Vol. 41, pp. 186-286 (Appendix No. 4), pls. 7-9, 1907. (The name of the Society was changed to Société Royale Zoologique et Malacologique de Belgique, but the Annales were continued in the same series.) Also in the "Essais de Paléoconchologie Comparée," 13 vols., 1895-1925.

Dall, W. H.: Various writings, especially in the Bulletins of the Museum of Comparative Zoology, Harvard College, Vol. 12, pp. 171-318, 1886; Vol. 18, pp. 1-492, 1889; in the Transactions of the Wagner Free Institute of Science (Philadelphia), Vol. 3, 1890-1903; in Professional Paper 59 U. S. Geological Survey, 1909; and in many publications of the Smithsonian Institution; etc.; etc.

Harris, G. F.: "Catalogue of the Tertiary Mollusca in the Department of Geology, British Museum (Natural History), Part 1, Australian Tertiary Mollusca," 1897.

Suter, H.: Manual of the New Zealand Mollusca (Wellington, N. Z.), 1913.

Thiele, J.: "Gastropoda . . ." Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition,Vol. 17, pp. 335-382, (Jena), 1925.

There are numerous other works, some of which are mentioned by Stewart, in which sporadic designations may be found. In very recent years authors have begun the very commendable practice of stating definitely the manner in which they have found each type to have been established,—notably:

Woodring, W. P.: Carnegie Institution of Washington, Publication No. 366 (Pelecypoda), 1925; Publication No. 385 (Gastropoda), 1928.

Stewart, R.: Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 78, pp. 287-447 (Gastropoda), January 3, 1927; Special Publication No. 3 of the Academy of Natural Sciences of Philadelphia (Lamellibranchiata), August 9, 1930.

Cox, L. R.: "Neogene and Quaternary Mollusca from the Zanzibar Protectorate," Report on the Palæontology of the Zanzibar Protectorate, pp. 13-102, September, 1927.

Similar treatment has been given types by Iredale, Marwick, Hedley, and some other modern authors.

In the case of specific names, a list is made in chronological order of publication of all the names that have been applied to specimens that fall within the genus or part of the genus under particular investigation. Then the validity of each name is tested as in the case of the generic names, and afterwards the identity of the type specimen is verified.

When both classes of names have reached this stage, zoological problems enter in. The type of the oldest valid name must be carefully studied in order to determine to what natural group of forms it is anchored. Then the types of all the other valid names must be taken up one by one in strictly chronological order to determine likewise to what natural group they are anchored. Those that fall within groups to which older valid names have been anchored must become either subordinate names or synonyms. This process requires a large amount of zoological research in addition to numerous references to the literature. In fact, classification should be entirely a zoological problem and the grouping of forms should not be influenced by the accidents of type fixing. Types should be thought of merely as anchors, holding names to particular parts of the animal kingdom; and it should not matter whether a type falls in the center or on the periphery of a group.

Classification

Nearly every zoologist will agree in principle that classifications should be governed as far as possible by the natural groupings of animals, that every division receiving a name should be composed of closely related forms all descended from the same remote ancestor, and that in most cases the division should contain all the descendants of that ancestor except such forms as have become so radically modified in characters as themselves to form another whole group of at least the same order of distinctness as the group from which they split. Artificial classifications that group together "for convenience" forms that have noticeable but superficial characters in common and separate closely related forms because of conspicuous but relatively unimportant characters, as well as classifications altered by preconceived artificial boundaries in time and space, are not to be tolerated by those who are working for scientific advancement, except as temporary makeshift arrangements in cases where knowledge is insufficient to give an indication of what the proper arrangement should be. In other words, it is agreed that the final criterion of classification must be phylogeny,—phylogeny, which can only be known from the imperfect paleontologic record and from the inheritance of similar structures from common ancestors, as indicated, not always reliably, by a study of living animals. But even when so much is agreed, differences of opinion must still arise as to the proper size of the various divisions, the most important of which are species and genera.

The species is a more natural unit than the genus. Darwin has shown[1] that because of the struggle for existence between the individuals of one species and those of another and between individuals of one variety and those of another the intermediate forms are apt to be squeezed out and exterminated. In its metropolis each form tends to multiply at a rate which would produce many more offspring than could possibly survive, and the greatest factor in keeping down the number of offspring is the competition of other forms. Since the competition is usually most severe between the most closely related forms, closely related species inhabiting adjacent regions or ecologic niches are important factors in limiting each other's distribution and adaptation. When a species is subjected to unusually rigorous competition, as it is when it is in contact with a closely related species, it usually can survive only where it is common. Hence it is, as Darwin explained, that the overlapping of closely related species in geographic distribution and in adaptation to particular ecologic niches usually occurs in comparatively limited zones and the transition from the territory of one species to that of another is in nature usually abrupt. The less common individuals of each species that live in the transition zones are continually being exterminated during adverse times by the combination of their enemies and are continually being replaced by new migrants from the areas in which their species are common. In a simple case a species is an aggregate of individuals living together and bounded in distribution by rather sharp lines. In a living state a species is often a fairly definite unit. The distinctness of species was recognized and *over*emphasized by the pre-Darwinian naturalists; but in modern times, since evolution has been generally accepted, it has been overlooked or *under*emphasized.

In most cases in nature, closely related species are kept separate either by physical boundaries or by their inability to interbreed. Here is the natural distinction between species and varieties. When varieties are adaptations to conditions that change gradually from one region to another, they will be connected by a broad transition zone of intermediate gradations. When they are adaptations of the individuals of a single species to more or less distinct conditions, they may have more or less distinct characters and the transition zones may be narrow, as with species, but through interbreeding numerous individuals will appear with the characters of the varieties mixed. The late Professor W. D. Matthew explained clearly in a paper delivered before a meeting of the Cordilleran Section of the Geological Society of America[2] that the *intergradation* and *intermingling* of the characters of two forms in a series of specimens is usually sufficient proof that the forms are varieties instead of species. Such a case is well illustrated by the varieties and variations of *Pecten purpuratus* in southern California and Lower California. It is obvious enough, when considered, that it is useless to try to give specific names to all the combinations of characters produced in individuals by the intercrossing of varieties which freely interbreed in nature, for the number of such combinations may reach the hundreds, and the natural facts would be obscured thereby instead of elucidated. It may sometimes be of value to name the outstanding forms as varieties, for varieties are expected to have intermediate variations, and specimens of intermediate characters would then have a place in the classification so that collectors and museum curators need not be faced by the alternative of throwing them away or naming them new species.

It is to be presumed that as a result of the geographic changes that have taken place in the past, physical barriers which once separated closely related species capable of interbreeding have sometimes been removed and have allowed the species to mingle and intercross freely. In time, paleontologists may be able to point to well authenticated examples of such situations, especially after the migrations of the past have been more carefully studied; but it is probable that such situations have occurred rarely and have not greatly influenced the course of evolution. In such cases paleontologists would mistake the two constituent species for *intergrading* and *intermingling* varieties; and in reality they should probably be considered so, for in time they would from interbreeding fuse into a single species, with modified characters. Thus in the living fauna, the magnitude of the group of individuals to which a *specific* name should be applied is determined by the boundaries of the group of individuals that are, or in special cases have been, freely interbreeding in a natural state. Some difficulty may occur in dealing with forms distributed along a long coast line. Forms extending perhaps from the tropics to the arctic and varying slightly from place to place may change accumulatively to such an extent that the extremes are very different in characters and perhaps could not interbreed. Even in such cases, however, the specific unit seems to cover best the whole series, for each variety would breed and intergrade with the one next to it.

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[1] "Origin of Species," particularly Chapters 3, 4, 6.

[2] Part of this paper has since been printed in the Bull. Geol. Soc. Amer., Vol. 41, pp. 271-274, 1930.

When the paleontologic record is also taken into consideration the problem of determining the size of the specific unit becomes somewhat more complex, though, as the present writers believe, not seriously so. Since the doctrine of evolution has become the basis of reasoning about such matters, it has often been said that if our records were complete every species could be traced back through its ancestry and be shown to intergrade ultimately with the ancestors of every other closely related species, that any two closely related species must have intergraded at some time, if they do not now do so. But although this proposition is true, it need not seriously impair our conception of a species as a natural unit. As has been pointed out by Darwin, H. S. Williams,[1] and others, evolution does not take place at a uniform rate but proceeds most rapidly at times when physical changes in the environment upset the equilibrium of a fauna. Such changes are the results of diastrophic revolutions, marked climatic revolutions, breaking of geographic boundaries in various ways, and lesser movements of similar natures such as commonly cause the division of sedimentary deposits into formations. "It is a more important consideration, leading to the same result, as lately insisted on by Dr. Falconer, namely, that the period during which each species underwent modification, though long as measured by years, was probably short in comparison with that during which it remained without undergoing any change."[2] It was mentioned in part 1 of the present paper that as the cold wave of the first glacial age was approaching at the end of the Pliocene a large number of common species, as well as rarer ones, became extinct during a comparatively short time. The faunal readjustment that took place then is surely of the sort in which new species would be formed; and it is safe to say that in California (and probably everywhere) equilibrium was again reached before the elapse of more than one-twentieth of all subsequent time, during which the faunal equilibria have not again been similarly upset. Probably the principal part of the development of each single new species took place in a comparatively much shorter time than that. Hence, if the development of new species begins locally, is confined to a comparatively few individuals, and proceeds rapidly so that the parent species and all the intermediate variations are exterminated quickly, the finding of specimens of intermediate characters should be very unusual.

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[1] Bull. 210, U. S. Geol. Survey.

[2] Darwin, "Origin of Species," Chapter 10.

Thus in the vertical, or time, scale as well as in the horizontal, or geographic distribution, scale, the transition from species to species is comparatively abrupt, and the species remains a natural unit. Although there necessarily are and always will be differences of opinion about certain forms, whether they should be called species or varieties, it is in many cases because the facts about these forms are not well enough known to show which they are. In the majority of cases the natural units can and will be recognized and so can be used as standards of comparison for the more imperfectly known forms.

The genus, on the other hand, is usually an artificial unit, created for the convenience of classification. The average size of the groups to which generic names are to be applied should be determined with the object of making generic names of the greatest use and the least trouble possible. The ideal size must be somewhere between two definite extremes, though the happy medium must always be a matter of personal opinion. No one worker should say that another is wrong if he extends his genera ever so far or if he confines them to ever so limited an application, so long as he does not bring them very close to either of the two extremes. Also, the tendency of the day should not be pointed to as authority for enforcing one opinion over another, for, to judge from the past, the "more advanced and more progressive" workers of twenty-five years from now are almost sure to be following a tendency or drift in another direction. Therefore, to approach the ideal and reach a state of comparative stability, each individual should base his opinion about the proper average size of genera upon what in his best judgment is the most *convenient* size for everyone concerned.

One extreme is the old Linnæan policy of classing the whole of the mollusca under a score or two of genera; the other extreme is to have a genus for every species. There is something to be said for the former extreme, for a few names are easy to remember and to use and they divide the class into groups each of which is easier to handle as a unit than the whole class. Nothing can be said in favor of the latter extreme, for it is the equivalent of discarding generic names altogether and making specific names twice as long and more than twice as hard to handle. The Linnæan system was meant to be binomial, and to be most useful the generic name was meant to be markedly different in breadth of application from the specific. Even a generic name for every well-marked species is almost obviously too close to the more unreasonable of the two extremes, for it makes the nomenclature too cumbersome, with too many names, all apt to be involved in nomenclatorial, time-wasting difficulties. Besides, the genera are needed for showing broader relationships, and the unit of the well-marked species and its close or doubtfully distinct relatives can be handled more satisfactorily in other ways.

Although there is something to be said for the Linnæan policy of having a very small number of genera, no one now advocates a return to that policy, for a larger number of names is now known to be more useful; but on the whole it appears to the present writers better to err in this direction than in the other, better to construe genera too broadly than to limit them too much to details. The systematist should hold constantly in mind that his names and classification are to be used by workers in other branches of his science or even in other sciences. When every systematist specializing in the minute details of classifying a very small part of the organic world thinks it useful to introduce a myriad of new names, which in most cases he cannot himself remember, and then virtually forces them on the rest of the scientific world by making them of generic rank, he greatly hampers the geneticist, the embryologist, the medical student, the geologist, and others in their work, for other scientists are usually interested chiefly in the definite or specific name of the thing they have and in its general relationships to the rest of its class as indicated by its generic name used in a broad sense. A generic name that does not meet these requirements is a nuisance to these other scientists, and one that attempts to tell other things instead is an unnecessary burden.

A strange argument has recently been put forth to justify creating many new generic names and confining the older we'l-known names to small insignificant groups of species, namely, that as the older names are usually of doubtful nomenclatorial status and their exact application is often subject to change, fewer species will be involved in the changes. In other words, it is suggested to make the unwelcome changes now to avoid the possibility of having to make them later. It might be noted here that if genera are used in a broad sense, such changes will usually mean merely a rearrangement of subgenera. Another argument to justify creating new generic names and limiting old ones is that the inclusion of various species in a genus should indicate that they are fairly closely related, whereas we often do not know whether they are or not, except that they appear to have a number of characters in common. If genera were smaller there would be less risk of including heterogeneous elements. However, if there were no genera, there would be still less risk, so the problem falls back again on the principle of the convenience of taking some risks in order to express relationships still imperfectly known, and the amount of risk that should be taken must be governed by the special circumstances of each case. It is a true, though very unfortunate circumstance that arguments in justification of a multiplication of names are too often merely a form of ratiocination engendered, usually subconsciously, by a desire for the supposed glory of being the author of the new names. During times when the multiplication of names is popular, many writers indulge in it as a sort of speculation not unlike speculative inflation of the stock market, and the process keeps on until the market is glutted with such securities and deflation and hard times ensue, if not a nomenclatorial panic, followed by a gradual return to a more reasonable intermediate position. Such fluctuations are costly in wasted energy, and it is better for science not to speculate too much in this way.

A compromise can be reached to combine the advantages of having numerous small divisions and the advantages of having larger, broadly-construed genera, without introducing any important disadvantages of either. It is to be found in the use of subgenera and sections. The genus name is the real name, according to the binomial system, and if there are comparatively few generic names, many workers, including the systematist, can afford to learn them by heart and speak and think of them familiarly. In most cases, the simple generic name coupled with the specific is all that is necessary in discursive references, in faunal lists, and in articles reporting on detailed studies of specific organisms made by those who are not systematists. With many more names, even the systematist cannot learn them and is forced to work on paper. Working on paper, there is no real disadvantage in having quinquenomials (genus, subgenus, section, species, variety), especially as the section need never be used except in a heading or by itself in referring to its group of species collectively, and even the subgenus can be treated that way if desired. It might be mentioned here that at least one of the present writers believes that in place of the sectional name a more desirable form of terminology would be "group of species so and so," as, for example, the "group of *Pecten gibbus*" for *Plagioctenium.* Sectional names are the names referred to above as ultimately to apply to every well-marked species and its group of closely related or doubtful species. The group and species designation has the advantage of being free from ancient nomenclatorial entanglements and of being more flexible and adaptable to the growing needs of science. Perhaps in a few cases both the sectional and the group designations could be used to advantage; but as employed in this paper and in most conchological works most sections mean no more than the group of this or that species.

Variation

Most of the foregoing and some of what is to come bears on the subject of nomenclatorial policy, which, after all, is of small importance compared with the zoological problem of determining the relations between organisms. Nomenclature is being dealt with at length here only because it is a necessary means of expressing organic relationships and is at present causing an unusual amount of trouble. It is not surprising that elementary students and many of those who make conchology a hobby, collecting shells as boys collect stamps, should never see or should at most times lose sight of the importance of organic relationships; but it is unfortunate that those who have assumed the role of leadership in conchology for the past thirty years have devoted themselves chiefly to nomenclature, to the description of new species and new genera, with scarcely ever a mention of relationships, of variation, of phylogeny, of migrations, or similar subjects. There are hopeful signs in the most recent publications that a change of attitude is taking place. Much data has been collected, but the most important work of organizing it, interpreting it, and digesting it has been left undone. The most interesting fields of endeavor have been touched upon by some of the older writers but by only a few modern workers, and these fields stand open now to everyone with opportunities for real accomplishment.

There is no molluscan species that does not vary in characters. Every year the *Zoological Record* publishes a small list of articles that describe the variations of a few species, but the number of variations that have been described is insignificant compared to the number that exist. It is important to be familiar with what has already been written on the subject; but it is still more important that students of mollusca should attempt to find out the extent and the limits of variation of the forms with which they work. Some species vary little, others much. Darwin has shown[1] that the wide-ranging, much-diffused, and common species vary most, especially the species of the larger genera, that is of genera that are themselves made up of many species. The many species represent many varying forms of the parent radical and bear witness of an inherent tendency in the lineage to vary and progress and become dominant.

The most striking contradiction to this natural rule is to be found in the fauna, as described, of small gastropods living off the western coast of North America. A number of genera are said to include hundreds of species, and yet these species are said to be without apparent variation. The species are separated by such fine distinctions that the smallest amount of variation would make one species into another or into a new species. In some cases the addition of one more spiral line to the shell (plain variation could hardly add less than one at a time) places a shell in another species. As many of the species have been described from and are still known from only one or two specimens, it is clear that variation has not been taken account of. Whereas it may be true that specimens may be comparatively constant in noticeable characters if collected from the same locality or from nearby localities of very similar ecologic conditions, it is almost certain that under somewhat different conditions variations will appear that do not represent distinct species. The genus *Lora* may serve as an example. It is certain that some species such as *L. viridula* and *L. turricula* have a large assortment of varieties and variations. Of the small collection of specimens representing some of the rarer species that the present writers had access to, few specimens, if any, conform exactly with the original description and figure of their species. Some are so distinctly intermediate between described forms that it was difficult to name them, and even the author of the majority of the species, who had identified a number of the specimens, did not always place them with the forms that they most closely resembled. There is no doubt that many names of species in *Lora* and other genera need to be synonymized as representing individual variations or should be reduced to varietal rank; and the present writers suspect that in extreme cases as many as twenty-five or fifty named forms should fall within the limits of variation of one natural species. When nearly every new specimen is as distinct as a "new species," and when many closely related species are reported living together, either there is something wrong with the treatment of the group or else there is something peculiar about the conditions under which the many species live, an explanation of which would be very enlightening. The treatment given *Lora* in the present paper is based on insufficient material and necessarily includes a number of errors. It is designed chiefly to classify the species already described so that it will be possible to identify specimens with a full knowledge of all the names that have been applied to similar forms. Although some of the synonymy may be incorrect, it is probable that still more names should be reduced in rank; the number of natural species is probably less, possibly much less than the number recognized. That is, not too many names have been synonymized, though in some cases, through lack of knowledge, the wrong ones may have been brought together.

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[1] "Origin of Species," Chapter 2.

Paleontologists are usually and Recent conchologists are often handicapped by the lack of a series of specimens sufficient to show what the natural units are. When this is the case, it is often said that it is better to name too many species than too few, or if the species have already been named, it is better to recognize too many than to synonymize some that should remain distinct. How often this argument is prompted subconsciously by a desire to be the author of new species, it is hard to say; but it is certain that it is in part fallacious. The reason advanced is that if two or more true species are classed as one, their records become mixed, to the great detriment of science, whereas if two variations of one species are kept separate no harm is done except the multiplication of labor in handling more names. However, the fact is that both errors are incorrect, and the present writers believe that one error should be as zealously avoided as the other. In actual practice, it happens that when two species are so similar that someone is tempted to synonymize them and are so imperfectly known that the basis of their separation has not been discovered, misidentifications are almost certain to mix the records. It often happens that some workers know of and consider only one of the names, whereas others know of and consider only the other, each identifying all his specimens as the species that has been called to his attention. In many cases the separation is made on the wrong basis, all Miocene species being assigned to one and all Pliocene to the other, or all northern California specimens to one and all southern California to the other, all with a weathered surface to one and all with a well-preserved surface to the other, or all with some conspicuous but inconsequential character to one and all without it to the other. Thus if the records of species easily confused are already mixed (and even where they are not it is often difficult to be sure that they are not), the separation gives a false sense of accuracy and the union of the two mixed records will be actually less misleading and to that extent beneficial. Careful workers realize that they must verify the records of specific distribution wherever possible. A frank admission that the true basis of separation is still unknown, as expressed in synonymizing a name, may have the further beneficial result of stimulating someone else with better material to discover and express the basis of distinction. On the other hand, if the two forms do not belong to distinct species, but are merely individual variations or varieties of little significance, much actual harm is done by keeping them separate artificially. Records of distribution are mutilated so that in the case of fossils geologists cannot make correlations with them, paleontologists cannot trace migrations or work out paleogeography correctly with them, and in the case of Recent shells ecologists and others are deprived of half the information available. Also, the classification is cluttered up with superfluous names and confused so that misidentifications are favored, and workers spend so much time and labor in trying to make separations which are of no value that the progress of science is seriously retarded. Therefore, when the tendency of the time is to create too many names, when descriptions are scattered in many places so that some are not known and comparisons are infrequent, when the classification has become so complex and indefinite that misidentifications are common, then it is better to try to bring the whole together and arrange it in logical order, synonymizing where no significant distinctions appear. To preserve names without logical distinctions, to say nothing of adding more names, would under such conditions help the confusion little. On the other hand, if the classification has been simplified and arranged in a logical order so that the distinctions already made are clear and the general tendency is to compress the species to too small a number, then it is better to examine the species carefully and attempt to find valid bases for making further distinctions. In other words, it does more good and less harm to run the risk of erring on the side away from whatever may be the popular tendency of the time and place. It is unsafe, then, to generalize that it is better to multiply names than to diminish their number. It is sometimes better to run risks in synonymizing, and the present writers believe that now is a time when more synonymizing is needed than is done even in the present paper.

Here also a compromise to the advantage of both sides can be made between those who believe in increasing names and those who believe in diminishing them. Well-marked species can be allowed the specific name, and studies of correlation, etc., can be made on the basis of the specific name, while the doubtfully distinct forms can be classed as varieties to retain whatever may be of value in their separate records. In this way the specific unit can be kept together and be made use of, while everything of value in the varieties will eventually appear, and misidentifications will be avoided because the close relationships will be evident to everyone and will receive proper consideration. Doubtfully distinct forms are seldom of any value in making correlations, for they are too unreliable; and when they have varietal standing only, there is less temptation to make unwarranted use of them.

Because so much emphasis is laid in the present paper on the study of variation and the broad construction of species as well as of genera (the natural specific units not always being determined by the facts available), it should not be supposed that the present writers would advocate overlooking a real distinction merely because it is a small one. Fine distinctions, no matter how hard to recognize and follow, should be as much respected as the larger, more striking differences, if it can be shown or if there is good reason to believe that they are truly of genetic significance. The practice that should be discouraged is the guessing that this or that difference is great enough to warrant creating a new species or retaining an old one when a knowledge of the variations of the form under consideration would in many cases show that its characters intergrade and intermingle with the characters of some species already named or of earlier date and that it is therefore only an individual variant. A conception of a species as an aggregate of many individual organisms living together and passing on to their descendants many different combinations of variable characters, all more or less affected by habitat, leads to a study of as large a series of specimens as is available. Such a study will usually reveal the natural relations and show whether a proposed distinction, either fine or coarse, is of genetic significance or not.

As specific characters vary within species, so do generic characters vary among the different species of a genus. But, whereas specific variants are separated by certain physical conditions from variants of other species, generic variants often intergrade, sometimes completely and in many cases with numerous other genera. In the absence of good paleontological records in the older formations and when it is difficult to get evidence of phylogeny from a study of the early growth stages, the intergradation of generic characters in species is the best index to generic relationships and phylogeny. All generic characters are subject to variation, and in most cases classifications based upon single characters prove inapplicable to the whole of a complex group. The *Turridæ* furnish a good example. The better known the different characters become, the more their variation is recognized. Shell characters are believed to be very variable, for they are the easiest to see and learn about. The radulæ, opercula, and nuclei are thought to be less variable, in part at least, because they are harder to study and are therefore less well known. Darwin concluded[1] that no one character can be relied upon always to show the proper relationships, for now one and now another will be affected by adaptation; but the best classifications are based on affinities in many characters considered together. Hence it is that the relations of species and the intergradation of their generic characters are the most useful criteria for indicating the relationships of the genera to which the species belong.

Migration of Species

A number of striking specific similarities between California species and corresponding forms in Japan, eastern United States, Europe, and Africa were run upon accidentally in the preparation of this paper, and these few instances indicate the existence of many more of the same sort. The older writers such as Carpenter and Conrad were well aware of such similarities in various species, though the limited amount of information available to them was not enough to show definitely the significance of the occurrences. Conrad surmised correctly that the presence of a form related to *Pecten jeffersonius* indicated the Miocene age of a California fauna. J. P. Smith has recognized the migration of faunal elements between the Atlantic and the Pacific in Eocene and Miocene times and also between Japan and the west coast of North America.[2] Ralph Arnold, T. W. Vaughan, and others have also noted migrations,[3] and many writers have recognized the fact of circumpolar migration of cold-water species in comparatively recent times. Mrs. I. S. Oldroyd and Miss Lydia Bowen are now preparing lists of analogous species from Africa, the Caribbean, and the Pacific coast of North America. G. D. Hanna and more recently W. P. Woodring have noted the migration of specific stocks between California and the Caribbean in the Miocene. However, some of these writers have been content with generalities and have not carried these generalities to logical conclusions, and those who have traced individual species or specific stocks from one region to another have only begun the work of bringing to light the many facts that can be discovered about these migrations. The idea of the provincial isolation of the California faunas in the present and the past has been altogether too prevalent among modern workers. It has become almost axiomatic that no California form can belong to the same species as any form from another region, no matter how much alike the two may be in characters, just as it used to be argued that no fossil species could be the same as a living species. Wide-ranging species are given new local names for this reason alone. As a gambling principle for those who want to be the authors of new names, this proposition is a good one, for often some fine distinction can be found to separate the two forms and the new names will be validated; but as a scientific principle it is not a good one.

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[1] "Origin of Species," Chapter 14.

[2] "Periodic Migration between the Asiatic and American Coasts of the Pacific Ocean," Amer. Journ. Sci., Ser. 4, Vol. 17, pp. 217-233, 1904.
"Ancient Portals of the Earth," Pop. Sci. Mo., Vol. 80, pp. 393-399, 1912.
"Climatic Relations of the Tertiary and Quaternary Faunas of the California Region," Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, pp. 123-173, 1919.

[3] Dickerson, R. E.: "Ancient Panama Canals," Proc. Calif. Acad. Sci., Ser. 4, Vol. 7, pp. 197-205, 1917.
Davies, A. M.: "Faunal Migrations since the Cretaceous Period," Proc. Geologists' Assn., Vol. 40, pp. 307-327, 1929.

Nearly all writers (except a few impossible extremists in Australia and New Zealand) recognize the presence of genera, subgenera, and sometimes even sections in different regions. The presence of one genus in two regions means that at some time conditions were sufficiently favorable for the migration of individuals belonging to that genus from one region to the other. Probably one individual could travel only a small part of the distance, but if living conditions were favorable, his descendants would each go a little way until at last the species would reach the other region, unless, perchance, it should have evolved by that time into another species. If the individuals of one genus are sufficiently adaptable or sufficiently hardy to make the journey, it is not unlikely that the individuals of some other genera could make the journey also. In cases where many genera are known to have passed from one region to another, especially if some of the genera are not particularly hardy or adaptable, there is good reason to believe that conditions were fairly favorable all along the way and that some of the more hardy and versatile species might make the journey without losing their specific identity. Because a species is a much more limited and more definite unit than a genus, these cases of the migration of species or of specific stocks (sections or groups of closely-related and doubtful species) provide the most accurate evidence for determining the exact nature and times of the interregional migrations.

The distribution of faunal provinces has in the past been very different from what it is now. In the Paleozoic and the Mesozoic, boundaries were fewer and the world was sometimes divided into only two or three great faunal provinces; perhaps once or twice there was only one great faunal community. In the Eocene, what boundaries there may have been did not keep the *Venericardia planicosta* fauna from appearing in nearly every part of the world. It makes little difference whether the varieties of the best-known species or specific stock of that fauna are disguised under many new specific or pseudospecific names or not, except that it does disguise them, obscuring relationships. Perhaps the present tendency to dismember *V. planicosta* is only a fad and will pass away as not in accord with the facts. Perhaps it is correct and will have to be put up with. In the Miocene there was another period of widespread migration. The communication between the various regions may have been as easy then as it had been in the Eocene, but the Miocene period of easy communication has not been so well recognized because the local representatives of each wide-ranging specific stock have been known under local names and their relationships have seldom been noticed. No one species, like *V. planicosta*, has been called by the same name in many different regions. Since the Miocene there has been no similar, nearly universal intermigration of warm and temperate faunas.

As the last of these periods, the Miocene is particularly important. Temperatures were more nearly uniform then than now. Passages into the Arctic appear to have been closed at least part of the time and the waters of the northern Pacific and northern Atlantic were protected from Arctic currents. Species that are now confined by temperature conditions to certain latitudes could then range much farther north and south and could pass east and west around the ends of the oceans. Furthermore, there were one or more connections between the Atlantic and the Pacific, one probably through Mexico and others farther south, to say nothing of possible channels through the Old World. In a broad sense, the Miocene coast lines can be thought of as chiefly east and west in contrast to the present north and south arrangement, and the whole temperate and warm-temperate zone of the northern hemisphere can be thought of as a single province, divided into subprovinces, perhaps, but the divisions no more distinct than subprovinces are today. Some writers state that the connection between the Japanese region and North America was formed at an earlier time or a later time, or both, than the other connections; but even if this is so, the migrations would still have been possible.

The Pectens are one of the best illustrations of these interregional migrations, for they are a versatile and dominant group, able to adapt themselves to a wide range of conditions; and many of them are capable of rapid locomotion, moving sometimes as much as several miles a day. *Pecten humphreysii* of Maryland, New Jersey, etc., *Pecten laqueatus* of Japan, and *Pecten aletes* of Lower California, whether one species or three, bear witness of a migration between the western coast of the Atlantic and Japan, probably through California. The present writers do not know the antiquity of this stock in Japan, and it is possible that the last lap of the journey was made from California to Japan in the Pliocene, though there is no evidence of it. It seems more probable that the migration took place entirely in the Miocene, the stock surviving in the Orient until the present day, in Lower California perhaps to the Pliocene, and in eastern United States apparently not outlasting the Miocene. In either case, the presence of the three forms in the three regions is incontestible proof of the migration. Similarly *Pecten* (*Amusium*) *japonicus* of Japan and *P. mortoni* of the Atlantic states Miocene appear to indicate Miocene migration between the two regions, though this case is not so certain. The Chinese *Pecten* (*Amusium*) *laurentii* has been reported in the California Miocene under what is probably an erroneous name; and *Pecten* (*Amusium*) *pleuronectes* of China and the East Indies is probably the same as *lompocensis* of the California Miocene and *cristatus* Brown of the Italian Miocene. The last occurrence suggests that some of the migrations may have been by the way of Europe.

The California upper Miocene *Pecten discus* may differ in minor respects from the European living and fossil *P. opercularis;* but it is just as sure an index of migration between the two regions. Similarly, the *Pecten swiftii* group, fossil and Recent in Japan and Miocene and Pliocene in California, is a certain index of migration to or from the Orient. There are many examples of species migrating between the Caribbean and California, a notable case among the Pectens being shown by *P. ziczac* of the Caribbean and *P. keepi* of the California and Lower California Pliocene (or Miocene ?). Another case of unquestionable Miocene migration between the Atlantic states and California is furnished by the *Lyropecten*, *P. jeffersonius* and its varieties or relatives. Large forms like the Lyropectens are known in Europe and other parts of the world and characterize the Miocene of certain latitudes. Another form of particular interest is *Pecten gibbus*, which appears to have originated in the Miocene of the Caribbean and is still living practically unchanged and in great abundance on both sides of North America.

But the Pectens are not the only group that furnishes examples of these migrations. The strange *Corbula gibbiformis* of the California Pliocene has so many of the peculiar characters of the European *C. gibba* that there can be little question about its close relationship, if indeed the two are not specifically identical. The stock must have migrated between the two regions in the Miocene, surviving in California only until the end of the Pliocene but in Europe lasting until the present day. Similarly *Mactra orthomorpha* of the California Pliocene is practically identical with *Mactra stultorum* of Europe. The California Miocene variety *longior* of the Atlantic living *Anatina* (*Raëta*) *plicatella* is likewise an example of transcontinental migration. Another Mactroid group, *Mactrella*, is represented in the living faunas of both coasts of Mexico and Central America by two forms (species, varieties, or variations) which must have lived through practically unchanged on both sides of the continent since the Miocene. Similarly, *Divaricella dentata* of the Atlantic and *eburnea* of the Pacific have become only varietally distinct. *Lucina* (*Miltha*) *xantusi*, Miocene to Recent of California and the Gulf of California, has long been confused with the Brazilian *L. childrenæ* (of which the present writers have not seen authentic specimens), and to judge from what has been said of these two forms they must have belonged to the same stock in the Miocene and may even yet be the same species. *Nucula* (*Acila*) *gettysburgensis* from the Oligocene of western North America is represented by a very similar form in the Miocene of the Panama Canal Zone and by nearly identical living Oriental forms. Similar examples among the gastropods have not been noticed by the present writers because during the preparation of the gastropod part of this paper time was becoming limited and they were not able to peruse the literature of other regions. Undoubtedly as many examples could be found among the gastropods. The living *Psephæa prevostiana* of the Japanese region is represented in the Miocene and Pliocene of the Pacific coast of North America by the variety *oregonensis*, which is so nearly identical in form that it is difficult to find an excuse for retaining it as a variety. *Ranella dilleri* from the Miocene of Oregon is almost identical with *R. gigantea*, the type of the genus, living in the Mediterranean.

It is possible that the *Psephæa* migrated between North America and Japan as late as the Pliocene, for at that time also there seems to have been a connection between Asia and North America. The same may be true of some of the other species mentioned and also of some of the Patinopectens. *Pecten yessoensis* of Japan, though now probably specifically distinct, is so clearly related to *P. caurinus*, (? Miocene or) Pliocene to Recent, of North America that it must have sprung from the same stock. Perhaps the somewhat cold-water adaptation of the Patinopectens facilitated this migration in the Pliocene. Even during the interglacial ages of the Pleistocene migration of warm-water species between North America and Asia may have been possible, and some species of *Haliotis* may have passed across at those times.

With the change in climatic conditions at the end of the Pliocene, the warm-water species retreated to comparatively isolated faunal pockets or provinces as we know them today, bounded by climatic and continental barriers. Then the cold-water species of the Arctic migrated down the shores of both oceans and found their way even farther south in deep water. Hence many genera and identical species have appeared in the north Atlantic and in the north Pacific, including species of *Astarte*, *Mya*, *Nuculana*, *Saxicava*, *Thyasira*, *Buccinum*, *Nucella*, *Lora* and other cold-water Turrids, and many others. Presumably there had been earlier opportunities for some of these species to make the journey around through the Arctic, for some are known to have lived in both oceans before the end of the Pliocene. Perhaps they did not have to wait until the end of the Pliocene to start the migration. Perhaps a few species got around in the Miocene or Oligocene through temporary breaks in the barriers. The Myas are well known throughout the California Pliocene, though they become more common near the end, and they are also known in the Miocene. *Mactra* (*Spisula*) *polynyma* of the Atlantic is represented in the California Pliocene and north Pacific Recent by the variety *voyi*, which probably migrated via the northern route. Some California Pliocene specimens of *Siliqua* greatly resemble the Atlantic living *Siliqua nahantensis*. Migrations of this sort may be still going on.

Here the question of nomenclature must come up again. How far should these migrating forms be recognized and called by the same names? The answer is, of course, a matter of personal opinion. A species that has comparatively recently migrated through the Arctic and appeared on both sides of the Atlantic and on both sides of the Pacific and is still connected by representatives at intermediate points must of course be kept under a single name, provided no appreciable evolutionary changes have taken place during its migrations. On the same principle, a Miocene warm-water species that was at one time in the process of extending its distribution from what is now one region to what is now another, making a journey that in many cases was no harder than the journey today around Florida from the Atlantic to the Gulf of Mexico, should be kept under a single name, unless there is evidence that appreciable evolutionary changes took place. The latter proposition is more difficult to apply than the former, and it has hardly ever been tried, for there are very few paleontologists who know enough of the literature of two regions to be able to do it. However, the present writers believe that it is the more scientific course and is worth while to try. For southern species, the migration between the Atlantic and the Pacific through Mexico or Central America was surely an easy matter in Miocene times and could be accomplished by many species without undergoing any marked changes in characters. At that time it was not inter-regional migration, but migration within a single province. Furthermore, it is usually agreed that a Miocene species which has survived in one region until the present without appreciable change should be known as a single species. Hence, if a Miocene form should survive in two regions without appreciable change, it should still be known by the same name in both regions, even though the regions are not at present connected. There are more such cases than are usually suspected. Finally, if the individuals in one region differ from those in another by a very small amount, such as may be merely a temporary reaction to certain environmental conditions (as individuals in one cove differ from those in another along a single shore line), and the difference appear to be not genetic but of the sort that would disappear in a few generations if the particular conditions causing it were removed, then the form could be recognized as a variety of the parent species. The last case appears to be illustrated by *Pecten gibbus* and its variety *circularis*. Surely it is an advantage to spread scientific knowledge from one region to another. It is an advantage to call a species by the same name in two regions, if it can be done without violating the principles of classification or the natural facts, for by doing so you call to mind through the use of the name the whole interesting and significant background of the specific history besides reducing the number of isolated facts that every worker must deal with. There is no advantage whatsoever in making artificial boundaries, and doing so is apt in the end to cause considerable trouble at the points where the separations are made. Of course in changing established usages it is worth while to be conservative, and in introducing names from other regions to wait until the evidence points clearly to the truth of the history that is implied by the proposed change; but on the whole the writers believe that specimens and species should be studied objectively without interposing any preconceived barriers in time or space. In that way only will many unsuspected important relationships come to light.

Bibliography

During the preparation of the following catalogue the writers compiled a bibliography which it was hoped could be published here. It grew to such proportions, however, that the time required to get it ready and the cost of publication became prohibitive. As a result, some of the references in the catalogue may be found to be inconveniently short; but in most cases an attempt was made to make the abbreviations fuller than in the majority of similar publications. Occasionally, a troublesome reference has been spelled out. Complete titles can usually be found by looking in the "Catalogue of the Books, etc., in the British Museum (Natural History)" by B. B. Woodward, which the present writers have found very useful. Other useful but more specialized bibliographies can be found in the fossil papers listed below by Arnold (1903) and by Dall (1909) and in the Recent papers by Dall (1909) and by Oldroyd. Binney's "Bibliography of North American Conchology"[1] is useful for papers published before 1860, especially as in many cases it summarizes the papers, giving for each American species the name used, the page, figure, and date. Also, *The Zoological Record*, which began in 1864 and contains references to nearly all papers published since its inception, should not be overlooked by those who wish to make a thorough search into the literature. Sherborn's *Index Animalium* has recently made itself indispensable. Unfortunately only a small part of Sherborn's valuable work was available during the preparation of most of this catalogue.

A few innovations in the details of arranging the references have been introduced in the interests of clarity. Misidentifications are not cited in the same way as ignorantly described new species, but the improperly used name is given as used in quotation marks. For example: "*Pecten cerrosensis* Gabb," Arnold, is given because it is less ambiguous than *Pecten cerrosensis* Arnold. The latter looks as if Arnold had described a homonym. In cases where the original usage of a name is not familiar to a reader, there is nothing to show in the latter form that the name is not available in that sense. Another very minor detail is in the capitalization of the words Series, Volume, Part, part, Number, number, Article, article, etc. An attempt is made to use capital letters when the division indicated is separately paginated and to use small letters when the pagination is continuous with the other divisions of the same rank. The writers regret not always being consistent in this matter. The writers also regret that the specific references are in many cases not complete. Occurrences and occasionally even illustrations in some bulletins published by the U. S. Geological Survey and in a few other publications have sometimes been omitted. However, it is believed that the majority of the important references have been included. Recent papers by Pressler, Stewart, and others appeared too late to be incorporated.

A few of the more important primarily paleontological papers dealing with the material of this catalogue are as follows (the works most important for the present subject are marked by an asterisk):

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[1] Smithsonian Miscellaneous Collections, Pt. 1, March, 1863; Pt. 2, June, 1864. (Separate indices for American and foreign authors.)

Conrad, T. A.: U. S. Pacific R. R. Reports, Vol. 5, Appendix, pp. 322-329, pls. 2-9, 1856 (previously printed without plates in the U. S. House of Representatives, Document No. 129, July, 1855); Vol. 6, pp. 69-73, pls. 2-5, 1857; Vol. 7, pp. 189-196, pls. 1-10, 1857; these publications reprinted (without the plates) by Dall in the appendix to the 1909 paper listed below.

———: "Descriptions of Three New Genera, Twenty-three New Species of Middle Tertiary Fossils from California and One from Texas," Proc. Acad. Nat. Sci. Phila., Vol. 8, pp. 312-316, 1857.

*Gabb, W. M.: Geological Survey of California, Paleontology, Vol. 2, sect. 1, pt. 1, pp. 1-38, 1866; pts. 2, 3, pp. 39-124, with plates, 1868-9.

Cooper, J. G.: "Catalogue of California Fossils," Seventh Annual Report of the California State Mineralogist, pp. 227-270, 1888.

———: "Additions to the Catalogue of California Fossils Obtained since 1888," California State Mining Bureau, Bull. No. 4, Pt. 3, pp. 23-33, 1894. (All of these early records are not included in the present catalogue.)

Dall, W. H.: "Contributions to the Tertiary Fauna of Florida," Transactions of the Wagner Free Institute of Science, Philadelphia, Vol. 3, pts. 1-6, 1890-1903.

*Arnold, Ralph: "The Paleontology and Stratigraphy of the Marine Pliocene and Pleistocene of San Pedro, California," Memoirs of the California Academy of Sciences, Vol. 3, June 27, 1903; reprinted as Contributions to Biology from the Hopkins Seaside Laboratory of the Leland Stanford Junior University, No. 31.

*———: "The Tertiary and Quaternary Pectens of California," U. S. Geological Survey, Professional Paper 47, 1906.

———: "New and Characteristic Species of Fossil Mollusks from the Oil-bearing Tertiary Formations of Southern California," Proceedings of the U. S. National Museum, Vol. 32, pp. 525-546, pls. 38-51, June 15, 1907; some of the plates reproduced in Bull. 309 of the U. S. Geological Survey.

———: "New and Characteristic Species of Fossil Mollusks from the Oil-bearing Tertiary Formations of Santa Barbara County, California," Smithsonian Miscellaneous Collections, Vol. 50, Publ. No. 1780, pp. 1-26 (Quarterly Issue, Vol. 4, pt. 4, pp. 419-447), pls. 50-58, December 13, 1907; plates 50 to 56 reproduced in Bull. 322 of the U. S. Geological Survey and plates 57 and 58 in Bull. 321.

———: "Descriptions of New Cretaceous and Tertiary Fossils from the Santa Cruz Mountains; California," Proceedings of the U. S. National Museum, Vol. 34, pp. 345-390, pls. 31-37, August 8, 1908.

*Dall, W. H.: "The Miocene of Astoria and Coos Bay, Oregon," U. S. Geological Survey, Professional Paper 59, April 2, 1909.

*Arnold, Ralph: "Paleontology of the Coalinga District, Fresno and Kings Counties, California," U. S. Geological Survey, Bull. No. 396, January 15, 1910, the plates reproduced in Bull. 398.

Martin, Bruce: "Descriptions of New Species of Fossil Mollusca from the Later Marine Neocene of California," Univ. Calif. Publ. Geol., Vol. 8, no. 7, pp. 181-202, pls. 19-22, August 6, 1914.

English, W. A.: "The Fernando Group near Newhall, California," Univ. Calif. Publ. Geol., Vol. 8, no. 8, pp. 203-218, pl. 23, November 7, 1914.

Nomland, J. O.: "Fauna from the Lower Pliocene at Jacalitos Creek and Waltham Canyon, Fresno County, California," Univ. Calif. Publ. Geol., Vol. 9, no. 14, pp. 199-214, pls. 9-11, February 24, 1916.

Moody, C. L.: "Fauna of the Fernando of Los Angeles," Univ. Calif. Publ. Geol., Vol. 10, no. 4, pp. 39-62, pls. 1, 2, October 11, 1916.

Nomland, J. O.: "The Etchegoin Pliocene of Middle California," Univ. Calif. Publ. Geol., Vol. 10, no. 14, pp. 191-254, pls. 14-20, April 19, 1917.

Howe, H. V.: "Faunal and Stratigraphic Relationships of the Empire Formation, Coos Bay, Oregon," Univ. Calif. Publ. Geol., Vol. 14, no. 3, pp. 85-114, pls. 7-12, September 8, 1922.

Stewart, R. B.: "Gabb's California Fossil Type Gastropods," Proc. Acad. Nat. Sci. Phila., Vol. 78, pp. 287-447, pls. 20-32, 5 text figures, published January 3, 1927.

Waterfall, L. N.: "A Contribution to the Paleontology of the Fernando Group, Ventura County, California," Univ. Calif. Publ. Geol., Vol. 18, no. 3, pp. 71-92, pls. 5, 6, April 6, 1929.

Pressler, E. D.: "The Fernando Group in the Las Posas-South Mountain District, Ventural County, California," Univ. Calif. Publ. Geol., Vol. 18, no. 13, pp. 325-345, 4 text figures, September 30, 1929.

Stewart, R. B.: "Gabb's California Cretaceous and Tertiary Type Lamellibranchs," Special Publication No. 3, Academy of Natural Sciences of Philadelphia, August 9, 1930.

For the sake of students in California and others who are engaged in identifying specimens or are considering the naming of new species, it may be worth while to point out that many more species are known in the Recent fauna than have been reported from the best known Pliocene or Pleistocene fossil faunas. As many Recent species range back into the Pleistocene and Pliocene, it is probable that many more of them will be found in a fossil state and it is the duty of paleontologists to become familiar with the Recent literature, to try to correlate fossils with their living representatives, and before imposing a new name on the scientific world to be sure that the form which it is proposed to name has not already a name in the Recent fauna. The same is also true of Miocene species. Many species of the Miocene, Pliocene, and warm-water Pleistocene faunas of California are now living only south of the United States and do not appear in the checklist by Dall (1921), or in the work by Oldroyd (1924-27), which is an expansion and illustration of that checklist. Unfortunately the literature of the Mexican and Central American coast is very incomplete. Besides the general world iconographies of Martini and Chemnitz, Kiener, Reeve, Sowerby, and Tryon, there are only a few scattered works. Some of the most important works dealing with the living faunas of the Pacific coast of the Americas are as follows:

Conrad, T. A.: "Descriptions of New Marine Shells from Upper California, collected by Thomas Nuttall, esq.," Journal of the Academy of Natural Sciences of Philadelphia, Series 1, Vol. 7, pp. 227-268, pls. 17-20, 1837; also various other papers in the Journals and Proceedings of the Academy of Natural Sciences and in the American Journal of Conchology.

Hinds, R. B.: "The Zoology of the Voyage of H. M. S. *Sulphur* under the command of Capt. Sir E. Belcher . . . during 1836-42 . . . Mollusca," published 1844.

Gould, A. A.: Various papers in the Proceedings of the Boston Society of Natural History and in the Boston Journal of Natural History; also "Mollusca and Shells of the U. S. Exploring Expedition," Report of the United States Exploring Expedition under the Command of Captain Charles Wilkes, Vol. 12, text, 1852; plates (folio), 1856; etc.

Adams, C. B.: "Catalogue of Shells Collected at Panama, with Notes on Synonymy, Station, and Habitat," Annals of the Lyceum of Natural History of New York, Vol. 5, pp. 229-548, 1852; also issued as a separate.

Carpenter, P. P.: "Catalogue of the Reigen Collection of Mazatlan Mollusca in the British Museum," July, 1855, to June, 1857.

——————: "Report on the Present State of our Knowledge with Regard to the Mollusca of the West Coast of North America," British Association for the Advancement of Science, Report for 1856, pp. 159-368, 1857.

——————: "Supplementary Report on the Present State of our Knowledge with Regard to the Mollusca of the West Coast of North America," British Association for the Advancement of Science, Report for 1863, pp. 517-686, August, 1864; reprinted with other papers and a general index in the Smithsonian Miscellaneous Collections, No. 252, 1872.

Dall, W. H.: "Descriptions of Sixty New Forms of Mollusks from the West Coast of North America and the North Pacific Ocean, with Notes on Others Already Described," American Journal of Conchology, Vol. 7, pp. 93-160, pls. 13-16, November, 1871.

——————: "Preliminary Report on the Collection of Mollusca and Brachiopoda Obtained [by the U. S. S. *Albatross*] in 1887-88," Proceedings of the U. S. National Museum, Vol. 12, pp. 219-362, pls. 5-14, March 7, 1890.

Stearns, R. E. C.: "Report on the Mollusk Fauna of the Galapagos Islands, with Descriptions of New Species," Proceedings of the U. S. National Museum, Vol. 16, pp. 353-450, pls. 51, 52, 1893.

——————: "The Shells of the Tres Marias and Other Localities Along the Shores of Lower California and the Gulf of California," Proceedings of the U. S. National Museum, Vol. 17, pp. 139-204, 1894.

Dall, W. H.: "The Mollusca and Brachiopoda" [obtained by the *Albatross* in the Eastern Pacific during 1891, 1904, and 1905], Bulletins of the Museum of Comparative Zoology, Harvard College, Vol. 43, pp. 205-531, pls. 1-22, 1908.

——————: "Report on a Collection of Shells from Peru, with a Summary of the Littoral Marine Mollusca of the Peruvian Zoological Province," Proceedings of the U. S. National Museum, Vol. 37, pp. 147-294, pls. 20-28, November 24, 1909.

Lamy, E.: "Pélécypodes Recueillis par M. L. Diguet dans le Golfe de Californie (1894-1905)," Journal de Conchyliologie, Vol. 57, pp. 207-254, 1909.

Zetek, James: "Los Moluscos de la Republique de Panama," La Revista Nueva, nos. 1 (July), 2 (August), 1918, reissued as a separate, 69 pp., 1918.

Packard, E. L.: "Molluscan Fauna from San Francisco Bay," Univ. Calif. Publ. Zool., Vol. 14, no. 2, pp. 199-452, pls. 14-60, September 12, 1918.

Dall, W. H.: "Summary of the Marine Shell-bearing Mollusks of the Northwest Coast of America, from San Diego, California, to the Polar Sea, . . . " etc., Bulletin 112 of the U. S. National Museum, February 24, 1921, (Additions and emendations appeared in the Proceedings of the U. S. National Museum, Vol. 63, Art. 30, 4 pp., April 12, 1923).

Oldroyd, Mrs. I. S.: "Marine Shells of Puget Sound and Vicinity," University of Washington, Publications of the Puget Sound Biological Station, Vol. 4, March, 1924.

——————: "The Marine Shells of the West Coast of North America," Stanford University Publications, University Series, Geological Sciences, Vol. 1 (Pelecypoda and Brachiopoda), 1924; Vol. 2, 3 pts. (Scaphopoda and Gastropoda, including the chitons), 1927.

Tomlin, J. R. LeB.: "Mollusca of the *St. George* Expedition; (I) The Pacific Coast of North America," Journal of Conchology, Vol. 18, pp. 153-170, 1927; pp. 187-198, 1928.

The writers regret that the 1930 paper by Stewart referred to in several places above did not appear in time for all of its nomenclatorial and other findings to be incorporated in the preparation of this catalogue. Some of the nomenclatorial discoveries were made possible by better library facilities than the present writers had access to. It is unfortunate that the unearthing of more obscure ancient publications will still threaten to upset the most carefully prepared nomenclatorial arrangements. A few changes have been made below in galley proof. The present writers wish to express to Dr. Stewart their appreciation of the kind of work his two papers on Gabb's types represent. It is to be hoped that someone will make a similar careful study of Conrad's and Carpenter's types.

San Diego Society of Natural History Fossil Localities

40. Santa Barbara County. About 1½ miles west of Goleta Point, and about 4 miles west-southwest of the town of Goleta, in fossiliferous soft sand overlying clay shale at beach on Campbell's Ranch. U. S. Grant, collector. *Upper Pleistocene terrace.*

41. Santa Clara County. Two or three miles southwest of Mayfield, in sandstone along a small creek. A specimen of *Ficus* secured here, probably at or near the type locality of *Ficus stanfordensis* Arnold. U. S. Grant, H. R. Gale, and L. W. Wiedey, collectors. *Middle Miocene.*

78. Ventura County. About half a mile south of Seacliff Station on Southern Pacific Railroad, about 8 miles north of Ventura, at the north end of a sea wall. A low terrace about 6 feet above sea level. (= Stanford University loc. 536.) U. S. Grant, collector. *Upper Pleistocene terrace.*

97. Orange County. In the northern part of the San Joaquin Hills, at an elevation of between 125 and 150 feet, just south of a hill reaching 300 feet. On the map of the Santa Ana quadrangle (U. S. Geol. Surv., Ed. 1901) about ½ inch west of the "J" in "San Joaquin." Wayne Loel, collector. *Upper Pleistocene terrace.*

98. Los Angeles County. Fossiliferous deposit in a canyon in the mesa northwest of Santa Monica, about 350 yards west of the corner of Beverly Boulevard and Cary Street, just west of Toyopa Drive. F. C. Clark, collector. *Upper Pleistocene terrace.*

99. Los Angeles County. Just west of Newport, at top of 25-foot embankment at edge of mesa. The fossiliferous stratum continues for some distance along the edge of the mesa. A. M. Strong and U. S. Grant, collectors. *Upper Pleistocene terrace.*

101. Santa Barbara County. About 100 yards west of the pier at the old Bath-house; in a sandstone embankment at the beach. Called "Bath-house Beach" by Arnold, 1903. U. S. Grant, collector. *Upper Pliocene.*

151. Santa Barbara County. On Maria Ygnacia Creek, about 1½ miles northeast of Goleta, in nearly vertical strata of unconsolidated fine sand. Van Court Warren, collector. *Upper Pliocene.*

201. Los Angeles County. About 20 feet down the south side of ridge from little knoll which is N. 75° W. of the first important fork of Elsmere Canyon below the granite contact; about the middle of the south boundary of the S.E. ¼, N.E. ¼, Sec. 7, T. 3 N., R. 15 W., Mt. San Bernardino B. and M.; elevation about 2025 feet; in conglomerate, upper horizon, Elsmere Canyon just below coarse Saugus conglomerate capping; about 300 feet stratigraphically above the lower horizon; most easily found by following along the ridge. H. R. Gale, collector. *Middle or lower Pliocene.*

202. Los Angeles County. A path cut into the side of the main canyon leads up a side canyon about opposite locality 201. It follows up the side canyon past a prospect in the oil sand and soon reaches the granite contact. Then it follows around a contour onto the next ridge to the southwest and turns up the crest of the ridge, ending just over the first hump. To the southwest on the hill slope and along the next creek is locality 202, near the center of the northern boundary of the N.W. ¼, S.W. ¼ of Section 8. In oil-stained sandstone just above the granite. An attempt was made to divide the 25+ feet of fossiliferous strata into three faunules, upper, middle, and lower, respectively. (= Stanford University loc. 177.) See also localities 207 and 208. H. R. Gale, collector. *Lower Pliocene.*

203. Los Angeles County. On the hill slope along the N.W. bank of the main branch of Elsmere Canyon just above the little side creek which heads off to the northwest and just below the big waterfall. S.E. ¼, N.W. ¼ of Section 8. In about 80 feet above the granite there are ten fairly distinct fossiliferous strata, which it was attempted to separate. Locality 203a is under the brush just above the waterfall. H. R. Gale, collector. *Lower Pliocene.*

204. Los Angeles County. In the bed and along the banks of the small side creek mentioned under 203. Locality 204a is on the steep canyon wall just west of the side creek. Elsmere Canyon. H. R. Gale, collector. *Lower Pliocene.*

205. Los Angeles County. On the same northwest side of the canyon west of locality 204a where the slope is less steep below with a vertical cliff above. Most of the fossils have weathered out of the cliff. H. R. Gale, collector. *Lower Pliocene.*

206. Los Angeles County. Along the north fork of the canyon (the north fork is not so apparent from the creek bed below because of its hanging mouth), and eastward toward locality 205 in the main canyon. S.W. ¼, N.W. ¼ of Section 8. Only the higher strata of locality 203 are present. See also locality 209. (= ? University of California loc. 1601.) Elsmere Canyon. H. R. Gale, collector. *Lower Pliocene.*

207. Los Angeles County. On the hill slope to the north of the end of the path on the ridge near locality 202, near Elsmere Canyon. H. R. Gale, collector. *Lower Pliocene.*

208. Los Angeles County. Near the oil prospect mentioned under locality 202 and up little gulch to the north. Locality 208a is in the cut made for the path in the wall of the main canyon just as it turns into the hanging side valley. Locality 208 proper is in the N.W. ¼, S.W. ¼ of Section 8, as shown on the map. Elsmere Canyon. H. R. Gale, collector. *Lower Pliocene.*

209. Los Angeles County. West of locality 205 and southwest of locality 206 below the forks of the canyon on the north side of the main canyon. S.W. ¼, N.W. ¼ of Section 8. In sandy shale and concretions. Elsmere Canyon. H. R. Gale, collector. *Lower Pliocene.*

210. Los Angeles County. Detritus in the bed of Elsmere Creek. H. R. Gale, collector. *Lower Pliocene.*

211. Los Angeles County. On the southwest limb of the syncline in the ridge over the southern end of the Fernando Pass railroad tunnel, half way up the slope opposite the point where the recently constructed real estate development side road turns back along the northeast side of the canyon, and below the first high point on the ridge northwest of the place that the tunnel passes under (loc. 214). About the center of the eastern boundary of the S.E. ¼, S.W. ¼, Sect. 13, T. 3 N., R. 16 W., Mt. San Bernardino B. and M. Pico formation but a higher horizon than found in Elsmere Canyon. H. R. Gale, collector; spring, 1927. *Middle Pliocene.*

212. Los Angeles County. On the dip-slope of the north limb of the syncline at the head of a broad amphitheatre north of locality 211, on the map not far below the first "N" in "TUNNEL." N.W. ¼, S.W. ¼ of Section 13. H. R. Gale, collector; spring, 1927. *Middle Pliocene.*

213. Los Angeles County. On the top of the same ridge about a mile northwest of locality 212, near the figures 2000 of the 2000-foot contour on the map. About the center of the N.W. ¼ of Section 14. This locality is the northwest end of the outcrops of the fossiliferous stratum represented by localities 211 to 214. It was pointed out by Mr. J. E. Eaton. H. R. Gale, collector; spring, 1927. *Middle Pliocene.*

214. Los Angeles County. On summit of ridge directly over railroad tunnel. S.W. ¼, S.E. ¼ of Section 13. This locality is the southeast limit of the outcrops of the fossiliferous stratum, where the outcrops on the two limbs of the syncline curve around the end of the ridge and join. H. R. Gale, collector; spring, 1927. *Middle Pliocene.*

215. Los Angeles County. On the top of the main ridge east of Fernando Pass, just below the granite contact. North boundary of the S.W. ¼, S.W. ¼ of Section 17, T. 3 N., R. 15 W., Mt. San Bernardino B. and M. Hard calcareous sandstone forming a knoll on the ridge. Elevation 2650 feet. (= ? University of California loc. 3588.) H. R. Gale, collector; spring, 1927. *Lower Pliocene.*

216. Los Angeles County. Coarse sandstone stratum about 12 feet above the granite at head of canyon just over the first hump to the north of locality 215. A path runs from near locality 215 northward along a side ridge toward Elsmere Canyon. After passing around the head of the second minor canyon which leads off to the west the path swings down on the west flank of the ridge. Locality 216 is on the north side of this second side canyon not far below the path and the top of the ridge. N.W. ¼, S.W. ¼ of Section 17. Locality 216a is ⅛ mile down the path from 216, toward Elsmere Canyon. H. R. Gale, collector; spring, 1927. *Lower Pliocene.*

217. Los Angeles County. Top of hill 2223 on the divide between Holser and San Martinez Grande canyons (so described by Kew in Bull. 753 U. S. Geol. Survey, p. 79, 1924; but the divide meant is the one going over into the canyon marked San Martinez Chiquito on the map). S.E. ¼, N.E. ¼, Section 7, T. 4 N., R. 17 W., Mt. San Bernardino B. and M. (= U. S. National Museum loc. 8140 and Stanford University loc. 178.) H. R. Gale, collector; summer, 1927. *Middle Pliocene.*

Locality 217a is on ridge running to the east-southeast.

Locality 217b is on the the ridge to the south-southeast. It may be University of California loc. 1637, which could not be located in the place described.

Locality 217c, detritus from Holser Creek; could have come from no other horizon.

218. Ventura County. Sulphur Canyon, east of South Mountain, on the east side of the long, narrow ridge running northward from the divide just east of the road, almost N. 45° W. from B. M. 1237. Locality discovered by Glenn E. Bader. H. R. Gale, collector; summer, 1927. *Upper Pliocene.*

219. Ventura County. Sexton Canyon, Santa Paula Quadrangle, just north of the junction with Lake Canyon, in clay bluff on right side of canyon going up. U. S. Grant, H. R. Gale, and Phil Wright, collectors; summer, 1927. *Upper Pliocene shaly facies.*

220. Ventura County. Knoll to the northwest of little, short, flat-bottomed valley west of Timber Canyon, Santa Paula Quadrangle. Fossils weather out on the southern hill slope below fanglomerate capping. See also locality 225 to the west. (= Stanford University loc. 254.) H. R. Gale, collector; summer, 1927. *Upper Pliocene.*

221. Ventura County. Second conglomerate ridge on the east side of Cañada de Aliso, north of Cañada Larga about ¼ mile, Ventura Quadrangle. (= Stanford University loc. 165 and University of California loc. 7096—Waterfall.) H. R. Gale, collector; summer, 1927. *Middle (or upper ?) Pliocene.*

222. Ventura County. At the head of Cañada de las Encinas about half way up the south side of the ridge separating it from Manuel Canyon, Ventura Quadrangle. (= Stanford University loc. 527.) H. R. Gale, collector; summer, 1927. *Middle (or upper ?) Pliocene.*

223. Ventura County. In conglomerate ledge on east side of the west branch of O'Hare Canyon just above the forks, about 1½ miles from the mouth of the canyon, Santa Paula Quadrangle. (= Stanford University loc. 234.) H. R. Gale, collector; summer, 1927. *Middle (or upper ?) Pliocene.*

224. Ventura County. In sandstone on ridge ¼ mile to the northwest of locality 223. H. R. Gale, collector; summer, 1927. *Middle (or upper ?) Pliocene.*

225. Ventura County. On the west side of the west branch of the large unnamed canyon between Timber Canyon and Santa Paula Creek, near the figures 1250 of the 1250-foot contour on the map. On the middle of the north border of the N.E. ¼, N.E. ¼, Section 35, T. 4 N., R. 21 W., Mt. San Bernardino B. and M., Santa Paula Quadrangle. In conglomerate about half way up slope. Locality 225a is on top of the ridge in sandy shale to the southwest. H. R. Gale, collector; summer, 1927. *Upper Pliocene.*

226. Ventura County. East side of Smith Canyon (first canyon east of Torrey Canyon) near its mouth in calcareous sandstone rib not far above the canyon bottom. Immediately overlying stratigraphically the Modelo sandstones, which contain poor fossils on the top of the ridge. (= ? U. S. National Museum loc. 8143.) H. R. Gale, collector; summer, 1927. *Middle Pliocene (?).*

227. Los Angeles County. On the northwest side of ridge running northeast from hill 2006, S. 33° W. of Humphreys Station, just north of the center of the S.W. ¼ of Section 27, T. 4 N., R. 15 W., Mt. San Bernardino B. and M. (= University of California loc. 3587.) H. R. Gale, collector; summer, 1927. *Lower Pliocene.*

228. Los Angeles County. Two-fifths of a mile south of north line of T. 3 N. and 1/10 mile east of meridian 118° 35′, mostly on south side of ridge immediately above bend in creek, southeast of Pico Canyon. (= U. S. National Museum loc. 8146.) H. R. Gale, collector; summer, 1927. *Middle Pliocene.*

229. Los Angeles County. On the summit of ridge near old water tank, west of the sharp bend in Pico Canyon which is just below the town of Pico. (= University of California loc. 1603.) H. R. Gale, collector; summer, 1927. *Lower or middle Pliocene.*

230. Los Angeles County. Just below top of steep southern escarpment of ridge north of potrero, or flat-bottomed valley, which heads west of the bend in Pico Canyon, 1⅗ miles N. 30° W. from the town of Pico. More easily accessible from the northeast or northwest, auto roads running in from the Santa Clara Valley (= ? U. S. National Museum loc. 1850. U. S. National Museum loc. 1842 could not be located from the description.) H. R. Gale, collector; summer, 1927. *Middle Pliocene.*

231. Los Angeles County. At the base of the escarpment below locality 330. H. R. Gale, collector; summer, 1927. *Middle Pliocene.*

232. Los Angeles County. On ridge extending to the northward in northeast corner of Section 32, T. 4 N., R. 15 W., Mt. San Bernardino B. and M., between Soledad and Placerita canyons, but more easily accessible from the former; a few poor fossils in a hard calcareous sandstone. H. R. Gale, collector; summer, 1927. *Lower Pliocene.*

233. Ventura County. Immediately below and east of top of ridge which makes the northwest corner of El Conejo Land Grant; north of Arroyo Santa Rosa. Fossiliferous unconsolidated sandstone overlying Sespe ? formation. (= U. S. National Museum loc. 8141.) U. S. Grant, collector; July, 1927, and January 4, 1928. *Las Posas formation, lower Pleistocene.*

234. Ventura County. Fossil reefs in old road-cut, about 75 feet above creek bottom on east side of Barlow Canyon (Santa Paula Quadrangle Map. U. S. G. S.) about ½ mile from mouth of canyon. Strike about N. 85° E.; dip about 37° south. (May be the same as Arnold's "Barlow Ranch Pleistocene.") U. S. Grant, collector; July 18, 1927. *Las Posas formation, lower Pleistocene.*

235. Ventura County. On divide between Hampton and Aliso canyons, due west of junction of Hampton and Wheeler canyons, on north side of hilltop at about 850-foot elevation, Santa Paula Quadrangle. U. S. Grant, collector; July 11, 1927. *Las Posas formation, lower Pleistocene.*

236. Ventura County. Just north of top of hill (at elevation of about 1100 feet) on east side of Harmon Canyon, 1½ miles above its confluence with the Santa Clara Valley. Just above upper Pliocene clay shale. U. S. Grant, collector; July 13, 1927. *Las Posas formation, lower Pleistocene.*

237. Ventura County. Fossils weathered out on small north-south ridge at about 750-foot elevation a half mile west of locality 244 in Sexton Canyon, at head of and 9/10 mile above mouth of small canyon lying half way between Sexton and Barlow canyons. H. R. Gale, collector; summer, 1927. *Las Posas formation, lower Pleistocene.*

238. Ventura County. East side of Adams Canyon about 1 mile above mouth, just at south edge of mouth of side canyon from east, in yellowish sandstone at or near base of Las Posas formation near contact with typical Pico clay shale. A conglomerate stratum occurs stratigraphically above (south of) this fossil molluscan reef. About 3 miles west of Santa Paula. U. S. Grant, collector; July 1, 1927. *Las Posas formation, lower Pleistocene.*

239. Ventura County. Divide between Adams and O'Hare canyons, south side (slope) of 800-foot hill about 1 mile north of Santa Clara Valley. Sandstone near Pico contact. (This is near Stanford University loc. 213.) U. S. Grant, collector. *Las Posas formation, lower Pleistocene.*

240. Ventura County. Fossiliferous sandstone exposed on cliff on west side of sharp ridge between Adams and Fagan canyons, about 100 yards south of 950-foot hill, ¾ mile north of Santa Clara Valley, Santa Paula Quadrangle. U. S. Grant, collector. *Las Posas formation, lower Pleistocene.*

241. Ventura County. On ridge ascending from the southwest up 1200-foot hill, on the east side of Harmon Canyon, 1½ miles above mouth. (Harmon Canyon is 2½ miles north-northeast of Montalvo.) Pico formation just below Las Posas contact. Pecten fragments. U. S. Grant, collector; July, 1927. *Upper Pliocene.*

Locality 241a is 200 yards south of locality 241. Float from the *Las Posas formation, lower Pleistocene.*

242. Ventura County. West side of Adams Canyon, about 1 mile above mouth, in fossiliferous sandstone at foot of prominent hill. (This is just across Adams Canyon from loc. 238.) Santa Paula Quadrangle. U. S. Grant, collector; July 5, 1927. *Las Posas formation, lower Pleistocene.*

243. Ventura County. Base of Las Posas formation on west side of Adam's Canyon, Santa Paula Quadrangle, on spur northeast of 1000-foot hill, just beyond houses. (Same as loc. 242.) H. R. Gale, collector; summer, 1927. *Las Posas formation, lower Pleistocene.*

244. Ventura County. At back of sheep corral, on west side of Sexton Canyon, Santa Paula Quadrangle, about a mile above the mouth and about ⅛ mile south of the junction of Lake and Sexton canyons, at or near the base of the Las Posas formation in brownish, fine-grained sandstone, which strikes about N. 70° E., and dips 30° south. H. R. Gale and U. S. Grant, collectors. *Las Posas formation, lower Pleistocene.*

245. Ventura County. Fossils on slope on the north side of short side canyon leading west-northwest from the main canyon which enters Santa Clara Valley about 1 mile east of the mouth of Harmon Canyon, Santa Paula Quadrangle. Apparently Pico arenaceous clay shale not far stratigraphically below the Las Posas contact. Fragments of *Patinopecten*, etc. U. S. Grant, collector; July 13, 1927. *Upper Pliocene.*

246. Ventura County. Fossil reef on the southwest cliff of a ridge and weathered out fossiliferous sandstone blocks on slope of a spur leading west toward ranch houses near central part of Section 29, T. 4 N., R. 20 W., San Bernardino B. and M.; about ½ mile from mouth of canyon, in hills on east side of the canyon; east of Timber Canyon. U. S. Grant, collector; January 2, 1928. *Las Posas formation, lower Pleistocene.*

247. Ventura County. About 1850 feet north of the corner of Poli and Kalorama streets, Ventura, in canyon draining south and about 1250 feet north of bridge across mouth of canyon, in fossiliferous sandstone, dipping south. U. S. Grant, collector; January 3, 1928. *Middle of Las Posas formation, lower Pleistocene.*

248. Ventura County. Outcrop of indurated basal Las Posas sandstone fossil reef 30 to 50 feet south of summit of hill just over 1200-foot altitude, a little south of center of Section 35, T. 4 N., R. 21 W., San Bernardino B. and M. The fossils are in cemented sandstone blocks just on the south slope of this hill, near the summit. Stratigraphically overlying this fossil zone are some brown conglomerate members. Strike N. 60° E., dip 70° to 80° south. U. S. Grant, collector; January 4, 1928. *Las Posas formation, lower Pleistocene.*

249. Ventura County. About 1600 feet north of the intersection of Kalorama and Poli streets, Ventura, in fossiliferous sandstone exposed in canyon draining south. This locality is about 250 feet south of locality 247. U. S. Grant, collector; January 3, 1928. *Middle of the Las Posas formation, lower Pleistocene.*

250. Ventura County. About 1250 feet north of the corner of Kalorama and Poli streets, Ventura, in fossiliferous sandstone in canyon draining south. This locality is about 350 feet south of locality 249. U. S. Grant, collector; January 3, 1928. *Middle of the Las Posos formation, lower Pleistocene.*

251. Los Angeles County. In the little saddle back of the most prominent little tongue sticking out from the west side of San Martinez Grande Canyon, near its mouth. Sandstone bed in shale. (cf. loc. 262.) H. R. Gale, collector (41); summer, 1928. *Middle Pliocene.*

253. Los Angeles County. Palomas Canyon, on the south side of ridge south of Palomas Canyon between the second and third minor canyons above the junction with Violin Canyon. H. R. Gale, collector (33); summer, 1928. *Lower middle Pliocene.*

254. Ventura County. Sulphur Canyon, south side of Sulphur Mountain, on top of east-west ridge southeast of big turn in the canyon at the base of the Pliocene section or the top of the Miocene. Fossils preserved only in one or two large concretions. H. R. Gale, collector (34); summer, 1928. *Lower Pliocene.*

255. Los Angeles County. Hasley Canyon; in shale in and near road cut almost at the head of the canyon, directly east of hill 2100 and south of the section number of Section 32 on the map. H. R. Gale, collector (35); summer, 1928. *Middle Pliocene, shaly facies.*

256. Los Angeles County. On the northwest corner of hill 1668 east of the big bend in San Martinez Chiquito Canyon. H. R. Gale, collector (38); summer, 1928. *Middle Pliocene, oyster bed facies.*

257. Los Angeles County. On minor spur projecting southward on side of synclinal ridge west of Fernando Pass, in the west ½ of the S.W. ¼ of Section 13, R. 16 W., T. 3 N., San Bernardino B. and M. H. R. Gale, collector (37); summer, 1928. *Middle Pliocene, normal facies.*

258. Los Angeles County. Oyster reef bed running along the crest of the ridge east of San Martinez Chiquito Canyon about half way between the mouth of the canyon and the big bend. H. R. Gale, collector (36); summer, 1928. *Middle Pliocene, oyster bed facies.*

259. Los Angeles County. Continuation of the horizon represented at locality 229, the lower zone of Pico Canyon, probably lower Pliocene, on the north side of hill 2010 about a mile and a half west of Pico. In a hard calcareous sandstone (compare localities 232, 254). H. R. Gale, collector (46); summer, 1928. *Lower or middle Pliocene.*

260. Los Angeles County. On the top of hill 2018 west of the northwest branch of San Martinez Chiquito Canyon. H. R. Gale, collector (40); summer, 1928. *Middle Pliocene, normal sandy facies.*

262. Los Angeles County. On the east side of San Martinez Grande Canyon northeast from locality 251. Probably approximately the same horizon. H. R. Gale, collector (42); summer, 1928. *Middle Pliocene.*

263. Los Angeles County. On the south side of the ridge north of the junction of Towsley and Wiley canyons. H. R. Gale, collector (43); summer, 1928. *Middle Pliocene, normal sandy facies.*

264. Los Angeles County. A continuation of 263 across the main canyon to the east. H. R. Gale, collector (44); summer, 1928. *Middle Pliocene, normal sandy facies.*

265. Los Angeles County. Continuation of same bed in the bottom of the side canyon north of Gavin Canyon, in the S.E. ¼ of Section 10. H. R. Gale, collector (45); summer, 1928. *Middle Pliocene, normal sandy facies.*

266. Los Angeles County. Southwest of hill 2018 across the branch of San Martinez Chiquito Canyon on southeast end of prominent ridge. H. R. Gale, collector (39); summer, 1928. *Middle Pliocene.*

267. Los Angeles County. On the top of the ridge west of and probably a continuation of locality 231, just west of the large "R" of "FRANCISCO" on the map of the Santa Suzana Quadrangle. H. R. Gale, collector (47); summer, 1928. *Middle Pliocene, sandy and shaly facies.*

Locality 267a, north across gulch, oyster bed facies.

268. Los Angeles County. Top and southwest end of the most conspicuous hill west of the flat-bottomed valley without a name that lies northwest of Pico, probably a continuation of 267—just west of the "F" of "FRANCISCO" on the map. H. R. Gale, collector (48); summer, 1928. *Middle Pliocene, sandy facies.*

269. Los Angeles County. In whitish sandstone lens directly south across the valley from locality 268. Echinoids abundant. H. R. Gale, collector (49); summer, 1928. *Middle Pliocene.*

442. Los Angeles and Ventura counties. In a small canyon on the north side of the Santa Clara Valley, about 1¼ miles west of San Martinez Grande Canyon and 3½ miles east of Camulos, on a ridge between the forks of the canyon about ⅝ of a mile from its mouth and approximately on the boundary line between Los Angeles and Ventura counties. Horizon probably a few hundred feet lower stratigraphically than locality 251. Alex Clark, collector; October, 1930. *Middle Pliocene (shaly facies ?).*

SYSTEMATIC CATALOGUE
WITH
DISCUSSIONS OF SPECIES AND GENERA

CLASS PELECYPODA

ORDER PRIONODESMACEA

Superfamily Solemyacea

Family SOLEMYACIDAE

Genus SOLEMYA Lamarck, 1818

Solemya Lamarck, Anim. s. Vert., Vol. 5, p. 488, 1818, *S. australis* and *S. mediterranea* included; Stoliczka, Geol. Surv. India, Memoirs, Pal. Indica, Cretaceous Fauna So. India, Vol. 3, p. 271, 1871; Meek, U. S. Geol. Surv. Territories, Vol. 9, pp. 126, 127, 1876; Dall, Nautilus, Vol. 22, p. 1, 1908; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 100, 1909.

"*Solenimya* Lamarck," Bowdich, Elem. Conch., Vol. 2, p. 8, 1822.

"*Solenomya* Lamarck," Menke, Synopsis meth. Moll. gen. spec., editio altera, p. 119, 1830 (revised spelling); Children, Quarterly Jour. Sci. Lit. Arts, p. 300, January, 1823; Bucquoy, Dautzenberg and Dollfus, Moll. Mar. Roussillon, Vol. 2, fasc. 26, p. 718, 1898.

Stephanopus Scacchi, Osserv. Zool., p. 3, 1833.

Type (by subsequent designation, Children, 1823), "*Solenomya mediterranea*" Lamarck, = *Solemya mediterranea* Lamarck, = *Solemya togata* (Poli), 1791, Test. Utr. Sic., Vol. 2, p. 42, pl. 15, fig. 20, as "*Tellina,*" *fide* Bucquoy, Dautzenberg and Dollfus; Recent, Adriatic and Mediterranean Seas, Atlantic Ocean off Spain, Madeira, West Africa, etc.

Shell elongate, Solen-shaped, rounded and gaping at both ends, covered by a rather tough, horny epidermis which extends beyond the ventral margins of the valves. Sculpture obscure or consisting of low radial bands which may project beyond the ventral margin of the shell or become separated by indentations of the margin. Umbones posterior, not prominent; hinge edentulous, with an obliquely inclined, somewhat triangular chondrophore, below which is a reinforcing rib on the inner surface of the valve, similar to the internal rib of *Siliqua*. Pallial line obscure, without definite sinus. Size from very small (*S. occidentalis* Desh., *S. vellum* Say, Florida and Massachusetts respectively, 7 to 15 mm. length) to large (*S. johnsoni* Dall, length, 115 mm.).

Geologic range: Paleozoic to Recent, (Carboniferous, possibly from Silurian, to Recent).

Distribution: Widely distributed; uncommon, generally deep water.

Dall (1908) has proposed the two subgenera, *Petrasma* (type, *S. borealis* Totten) and *Acharax* (type, *S. johnsoni* Dall), but the hinge characters upon which they are based are not apt to be visible on fossil specimens. Dall places *S. ventricosa* Conrad in *Acharax*, probably because of the external similarity between Conrad's species and *S. johnsoni* Dall.

Solemya ventricosa Conrad

Solemya ventricosa Conrad, Geol. U. S. Expl. Exped., p. 723, Atlas, pl. 17, figs. 7, 8, 1849; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 101, 1909; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 174, pl. 1, fig. 1, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 583, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 240, 254, 1916; Weaver, Proc. Calif. Acad. Sci., Ser. 4, Vol. 6, p. 37, 1916; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4 (whole No. 204), p. 305, 1922; Clark, Univ. Calif. Publ. Geol., Vol. 15, p. 73, 1924.

Donax? protexta Conrad, Geol. U. S. Expl. Exped., p. 723, Atlas, pl. 17, fig. 9, 1849, *fide* Dall, 1909.

Solena protexta Conrad, Amer. Jour. Conch., Vol. 1, p. 152, 1865.

Plectosolen protexta Conrad, Meek, Checklist Mioc. Foss. N. A., p. 9, 1866.

Solen (*Hypogella*) *protexta* Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 89, 1868-9.

"*Machaera patula*" Gabb, *op. cit.*, p. 89, not of Carpenter, *fide* Dall, 1909.

Type specimen: In U. S. National Museum.

Type locality: Astoria, Oregon; Miocene.

Oligocene: Bainbridge Island, Washington (Arnold and Hannibal); Kitsap County, Washington (Weaver); *Acilo gettysburgensis* zone (Reagan, Clark, etc.).

Miocene: Astoria, Oregon (Conrad, Dall, etc.); mouth of Bear River, Humboldt County, California (Martin), etc.

?Pliocene: ? Lower Wildcat formation, California (Weaver).

This is a rather large species, said to resemble *S. johnsoni* Dall of the deep-water Recent fauna of Lower California. It ranges at least from the middle Oligocene to well up in the Miocene. We have not seen specimens or figures of specimens from the undoubted Pliocene. The possible occurrence of this species in the Pliocene rests upon the report by Weaver.

Solemya dalli Clark,[1] of the Oligocene of Washington, is a more elongate species with less prominent or eroded sculpture. Clark and Woodford[2] have reported a species from the Meganos, middle Eocene, of California.

Superfamily NUCULACEA

Family NUCULIDAE

Shell compact, ovoid, generally produced anteriorly and short posteriorly; hinge with an anterior and posterior series of comb-like teeth (taxodont) separated below the umbones by a ligamental pit; pallial line entire; internal layer of shell pearly. Animal with mantle margins free; no distinct siphons.

This family differs from the *Nuculanidæ* in the posterior truncation, the lack of developed siphons and the consequent entire pallial impression, the completely closed shells, and the pearly inner shell-layer. The *Ctenodontidæ* have a continuous arched row of taxodont teeth, not separated under the beaks by a resilial pit. These latter are Ordovician and Silurian.

The *Nuculidæ* are represented in the Paleozoic, apparently as early as the lower Silurian. They do not appear to have increased in abundance since Tertiary times.

Genus NUCULA Lamarck, 1799

Nucula Lamarck, Mém. Soc. Hist. Nat. Paris, p. 87, 1799.

Type (by monotypy), *Arca nucleus* Linnæus, figured herewith, plate 1, figs. 4, 5.

Shell small, compact, closed all around; shape ovate-trigonal with the posterior end subtruncate or short, the anterior end produced or broadly rounded; hinge with an anterior and a shorter posterior series of comb-like, typically chevron-shaped teeth, deeply interlocking, the series divided under the umbo by a chondrophore; sculpture inconspicuous or with fine radial ribs and concentric striations; inner shell layer pearly; inner ventral margins often crenulated.

Geologic range: Silurian to Recent.

Distribution: In all seas; shallow water to considerable depths; more common in cold water.

It is probable that the Tertiary Nuculas have been over-named. Some species are quite variable and individuals may seem to represent distinct species till sufficient material fills in the gaps in the series of variations.

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[1] Univ. Calif. Publ. Geol., Vol. 15, p. 73, pl. 22, fig. 3, Jan. 5, 1925. Type in Univ. Calif. Collection.

[2] Univ. Calif. Publ. Geol., Vol. 17, p. 85, pl. 14, fig. 1, 1927.

Subgenus **NUCULA**, s. s.

Shell with radial or concentric but not divaricate sculpture.

Nucula (Nucula) exigua Sowerby

Nucula exigua Sowerby, Proc. Zool. Soc. London for 1832, p. 198, 1833; Carpenter, Cat. Reigen Coll. Mazat. Moll., p. 145 (questionably), 1857; Hanley, in Sowerby, Thes. Conchyl., Vol. 3, *Nuculidæ*, p. 154, fig. 136, 1860; Sowerby, Reeve's Conch. Icon., Vol. 18, *Nucula*, sp. 26, fig. 26, 1870; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 577, 1895; Bull. Mus. Comp. Zool., Vol. 43, p. 370, 1908; Bull. 112, U. S. Nat. Mus., p. 10, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 13, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Nucula (Nucula) suprastriata Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 96, pl. 18, fig. 6, 1903.

Nucula suprastriata Carpenter, Keep, West American Shells, p. 20, 1904; T. S. Oldroyd, Nautilus, Vol. 28, p. 82, 1914.

Type specimen: In British Museum.

Type locality: Bay of Caracas, West Colombia.

Pliocene: San Diego Well, Balboa Park, San Diego (Coll. by H. Hemphill; Dall, 1895); lower Merced at Seven Mile Beach, San Mateo County; middle Wildcat formation, northern California (Martin).

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, Los Angeles County, rare; upper San Pedro of San Pedro and Los Cerritos (= Signal Hill), Los Angeles County; Pleistocene of Spanish Bight (Arnold, 1903); Pleistocene of Signal Hill, Los Angeles County (T. S. Oldroyd, 1914); upper San Pedro of Santa Monica, Los Angeles County (Oldroyd collection); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926).

Recent: Golden Gate, middle California, to Panama, Galapagos, and west coast of Patagonia (Dall, 1908, 1921).

This small trigonal species has strong, uniform concentric sculpture and crenulated inner ventral margins which at once separate it from *N. tenuis* Montagu, a circumboreal species with smooth ventral margins and sculpture consisting of indefinite irregular growth lines. *N. tenuis* also averages larger in size. *N. linki* Dall[1] also averages larger than California specimens of *N. exigua*, is less posteriorly truncate, and the concentric sculpture is finer and less uniform.

We have not found any publication by Carpenter in which a "*Nucula suprastriata*" is described by him. It is possible the name was used by Carpenter in labeling specimens now at the National Museum and that Dall, through some inadvertence, applied the unpublished name to specimens lent to him for identification. Arnold described and figured a "*Nucula suprastriata* Carpenter" without giving a reference to the original description, if there ever was one prior to his own. His figure and specimens at Stanford University convince us the shell he had was *Nucula exigua* Sowerby.

Nucula (Nucula) tenuis (Montagu)

Arca tenuis Montagu, Test. Brit., Supplement., p. 56, pl. 29, fig. 1, 1808.

Nucula tenuis Montagu, Forbes and Hanley, Hist. Brit. Moll., Vol. 2, pp. 223, 224, pl. 47, fig. 6, 1853; Dall, U. S. Geol. Surv., 17th Ann. Rept. pt. 1, p. 844, 1896 (erroneously as of Lamarck); Dall, in Spurr, U. S. Geol. Surv., 20th Ann. Rept., pt. 7, p. 174, 1900 (erroneously as of Lamarck); Dall, Bull. 112, U. S. Nat. Mus., p. 9, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 13, pl. 5, fig. 12, pl. 37, fig. 4, 1924.

Type specimen: In British Museum.

Type locality: Dunbar, Britain.

Miocene: "Miocene" of St. Paul Island and Nushagak, Alaska (Dall).

Recent: Point Barrow to Coronado Islands; circumboreal (Dall).

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[1] Proc. U. S. Nat. Mus., Vol. 52, p. 394, 1916, unfigured.

This species belongs to the group with smooth inner ventral margins. In this character and the less abruptly truncate posterior end it differs considerably from *N. exigua* Sowerby. Furthermore, it lacks sculpture except for low, irregular growth lines. The epidermis on Recent specimens is a light yellowish brown, highly glossy.

Nucula (? Nucula) townsendi Dall

Nucula cuneiformis Conrad, Amer. Jour. Sci., 2nd Ser. Vol. 5, p. 432, fig. 2, 1848, reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 150, fig. 2, 1909; not of Sowerby, 1837.

Nucula townsendi Dall, U. S. Geol. Surv., Prof. Paper 59, p. 101, new name for *N. cuneiformis* Conrad, not Sowerby.

Type specimen: In U. S. National Museum.

Type locality: Miocene (?) on Columbia River, near Astoria, Oregon.

The following is Conrad's original description:

> "Ovate, ventricose in the middle, with strong lines of growth; anterior side short, margin rounded; posterior side cuneiform; subtruncated at the extremity; basal margin rounded."

This description and Conrad's figure are hardly sufficient to define the species. By the anterior side he meant posterior side. Dall (1909) stated that Conrad's figured specimen was lost but that the single other specimen remaining "had coarse and somewhat irregular concentric narrow ridges with subequal interspaces that are marked by fine radiating sulci, which in some places crenulate the crests of the ridges and appear to have existed over the whole surface, but especially in the depressions."

* * *

Several other species of *Nucula* have been described from pre-Pliocene formations. *N. washingtonensis* Weaver[1] of the lower Miocene ("*Arca montereyana* zone") of western Washington is an unusually ventricose species. In shape it is not greatly unlike *N. townsendi* Dall, but the latter is based on poorly preserved material and Conrad's figure may not be accurate. However, the later named species should be compared with the type of *N. townsendi*.

Clark has described a *Nucula bifida*[2] from the San Lorenzo series (Oligocene) of Contra Costa County which is characterized by strong rounded radiating ribs unlike any other west coast species of the genus. The hinge plate has not been seen and its assignment to *Nucula* is based on shape.

Subgenus **ACILA** H. and A. Adams, 1858

Acila H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 545, January 1858; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 325, 1871.

Type (by subsequent designation, Stoliczka, 1871), *Nucula divaricata* Hinds.

Shell with the surface of the valves divaricately sculptured.

Geologic range: Mesozoic to Recent; probably from the Jurassic.[3]

Distribution: Northern and tropical Pacific.

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[1] Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 34, pl. 3, figs. 27, 28 and 29, 1916.

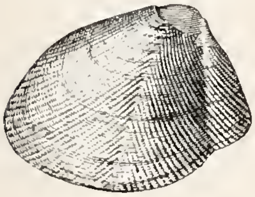
[2] Univ. Calif. Publ. Geol., Vol. 11, p. 122, pl. 12, figs. 10, 11, 12, 1918.

[3] See Davis, C. H., Journ. Geol., Vol. 21, p. 455, 1913, an unnamed species of *Acila* reported from the Jurassic slates of the Santa Lucia Mts. The presence of *Acila* in the Cretaceous is well substantiated.

The type of this subgenus, *N. divaricata* Hinds, 1843, not Conrad, 1848, is a Recent species of the China Sea; it is figured by Hinds,[1] Hanley,[2] Sowerby,[3] Chenu,[4] and others.

Section ACILA, s. s.

Shell with the posterior ventral margins of the valves produced into a short rostrum set off from the rest of the shell by a shallow sinus extending from near the umbones to the ventral margins just forward of the posterior end of the shell.



TEXT FIGURE 1. *Nucula (Acila) gettysburgensis* Reagan, specimen No. 375 S. D. S. N. H., from the Twin River shales, upper Oligocene, in the sea cliffs on the south shore of the Strait of Juan de Fuca, about one mile west of the mouth of West Twin River, Washington. Exterior of left valve, natural size.

In beds which have been assigned to the Oligocene the *Acila gettysburgensis*[5] clan of rostrate forms occurs in some abundance. *Acila gettysburgensis* (Reagan) is readily distinguished from the *castrensis* clan by its somewhat produced posterior ventral margin, the slightly protruding or rostrate part being marked off from the remainder of the shell by a shallow depression extending from the ventral margin toward the umbones. This produces a slight insinuation in the profile of the ventral margin of the valves near the posterior extremity. *Nucula (Acila) shumardi* Dall[6] and *Nucula (Acila) dalli* Arnold[7] appear to belong to the *gettysburgensis* clan, but the posterior ventral portions of these two species are not so rostrate as in Reagan's species. It is of interest to note that the Oligocene *A. gettysburgensis* has two Recent analogues in the western Pacific, *Acila mirabilis* (Adams and Reeve),[8] living off Japan and Korea, and *Acila fultoni* E. A. Smith[9] from deep water in the Bay of Bengal. This latter species differs from *mirabilis* principally in size and lighter coloration, and is very close to the Oligocene *A. gettysburgensis* (Reagan). *A. mirabilis* (Adams and Reeve) occurs fossil in Japan, occurring at least as low as the Pliocene.[10] A Recent specimen from Japan is figured herewith, plate 1, figures 3*a*, 3*b*. *Nucula (Acila) isthmica* Brown and Pilsbry[11] of the Gatun formation, Miocene of the Canal Zone, belongs to the rostrated section of *Acila*.

Nucula (Acila) semirostrata, new species

Text figures 2*a*, 2*b*, 3*a*, 3*b*

Shell relatively large, abruptly truncated posteriorly; ventral and dorsal margins broadly curved, anterior margin strongly curved, the ventral margin slightly and broadly insinuated about three millimeters from the abruptly curved posterior ventral end of the shell; posterior area rather broad, slightly concave and very little flared or pouted where the two valves meet; umbonal angle about 88 or 90 degrees; valves sculptured with numerous raised radial riblets which divaricate along an axis somewhat anterior to the lateral medial line of the valves; hinge with about 19 anterior and about 10 posterior teeth, those near the umbo closely appressed, the two series slightly separated by a small resilial pit; adductor scars prominent, variable in shape. Dimensions (of the type specimen): Length, 26½ mm.; height, 22½ mm.; convexity (one valve), 8½ mm.

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[1] Hinds, Proc. Zool. Soc. London for 1843, p. 97; Voy. Sulphur, Zool., p. 62, pl. 18, fig. 4, 1844.

[2] Hanley, in Sowerby's Thes. Conchyl., Vol. 3, p. 155, pl. 230, fig. 151, 1860.

[3] Sowerby, Reeve's Conch. Icon., Vol. 18, *Nucula*, pl. 4, fig. 29, Oct. 1870.

[4] Chenu, Man. Conchyl., Vol. 2, p. 179, fig. 899, 1862.

[5] *Nucula (Acila) gettysburgensis* Reagan, Trans. Kansas Academy of Sciences, Vol. 22, p. 175, pl. 1, fig. 3, November 24, 1909.

[6] This is the "*Nucula (Acila) decisa* Conrad" Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 573, April, 1898, pl. 40, figures 1, 3, Dec. 1900 (not of Conrad), renamed as distinct from Conrad's species by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 103, April 2, 1909.

[7] Proc. U. S. Nat. Mus., Vol. 34, p. 364, pl. 33, fig. 15, August 8, 1908.

[8] Moll. Voyage Samarang, p. 75, pl. 21, fig. 8, 1848; also figured by Hanley in Sowerby's Thes. Conchyl., Vol. 3, *Nucula*, pl. 229, fig. 114, and by Sowerby in Reeve's Conch. Icon., Vol. 18, *Nucula*, pl. 1, fig. 4.

[9] Journ. Conchology, Vol. 7, pp. 111, 112, Oct. 1892.

[10] Consult S. Tokunaga, Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. 21, Art. 2, p. 56, 1906; Yokoyama, Japanese Jour. Geol. Geogr., Vol. 2, No. 1, p. 9, 1923; Yokoyama, Jour. Faculty Sci. Imp. Univ. Tokyo, Sect. 2, Vol. 1, pt. 4, pp. 129, 137, pl. 16, fig. 1*a*, 1926. *Nucula cobboldiæ* Sowerby, a Crag Pliocene species, has been identified from the Japanese Pliocene, a range which suggests that a more careful comparison of California fossils with those of Japan is desirable.

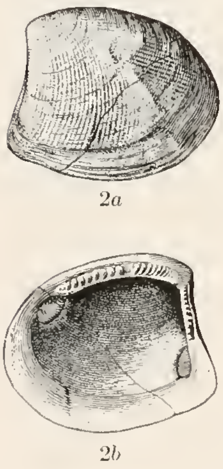
[11] Proc. Acad. Nat. Sci. Phila., Vol. 63, pp. 361, 362, pl. 27, figs. 11, 12, April, 1911.

Type specimens: Holotype, No. 370 in the type collection of the San Diego Society of Natural History (figured right valve); paratype, No. 371 (figured right valve); paratypes, Nos. 372, 373 (unfigured left valves); paratype, No. 5338 in the collection of the California Academy of Sciences (unfigured right valve); paratype, Los Angeles Museum of History, Science, and Art, fossil invertebrate type No. 2 (unfigured left valve).

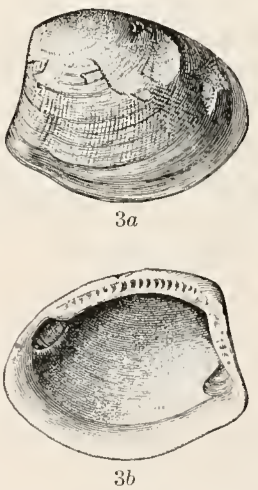
Type locality: S. D. S. N. H. locality 442, on a spur in a small canyon about 1¼ miles west of San Martinez Grande Canyon, north side of Santa Clara Valley, approximately on the boundary line between Los Angeles and Ventura counties, California; middle Pliocene. Collected by Alex Clark.

Pliocene: Middle Pliocene at the type locality.

This form is not only very variable in shape and in the strength of the posterior sulcus (or insinuation), but it is strikingly similar to other forms reported from the older Tertiary of the Northwest. As in the *castrensis* group, so in the typical section of *Acila*, distinctions between the various forms are hard to make and are usually of doubtful significance. *Nucula* (*Acila*) *castrensis* appears to range without significant change from the Oligocene to the Recent, and *gettysburgensis* is represented by living forms in the Orient that may be conspecific. Hence, it is probable that *semirostrata* will eventually be recognized as a variety or even a synonym of one of the older species. The matter of greatest importance to be recorded here is the Pliocene occurrence of the typical *Acila* group in southern California. Although the proposing of new names without previously establishing objective distinctions is in most cases to be strongly condemned, the writers believe that their present course is justifiable. There appear to be sufficiently important objective distinctions between *semirostrata* and the previously named forms to separate the former as a variety, and as the classification of the previously named forms is in such a state of indefiniteness, impossible at the present time for the writers to unravel, it is not clear to what species *semirostrata* should be assigned as a variety, and it appears better to set it up independently. It is expected that as a varietal name it will be useful and not a burden to the literature. Dr. H. G. Schenck of Stanford University is at present engaged in an extensive study of the Acilas, especially those of the Northwest, and the results of his work will undoubtedly clarify some of these problems.



TEXT FIGURE 2. *Nucula* (*Acila*) *semirostrata*, new species, type specimen, No. 370 S. D. S. N. H., from locality 442, middle Pliocene of the Ventura basin; natural size. Fig. 2*a*, exterior of the right valve; fig 2*b*, interior of the same valve.



TEXT FIGURE 3. *Nucula* (*Acila*) *semirostrata*, new species, paratype, specimen No. 371 S. D. S. N. H., from the same locality as the specimen shown in text figure 2; natural size. Fig. 3*a*, exterior of the right valve; fig. 3*b*, interior of the same valve.

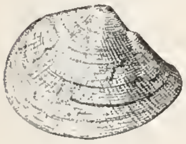
Nucula (*Acila*) *shumardi* Dall, of the Oligocene of Oregon and Washington, is perhaps the most like *semirostrata* in shape. The few specimens available for comparison seem to show that the posterior rostration of *shumardi* is exceedingly faint, the sculpture more delicate, and the size smaller. Both *mirabilis* and *gettysburgensis* appear to have typically a stronger posterior sulcation, a larger apical angle, and a more prominent pout on the posterior area; but more southern specimens of the latter approach the form of *semirostrata* more closely. Dr. Schenck has pointed out to the writers the similarity of variety *ashiyaensis* Nagao of *mirabilis* from the Yamaga beds of the province of Chikuzen, Japan. His recognition of *gettysburgensis* in the middle Miocene helps to bridge the time gap. It is not unlikely that *semirostrata* is a southern variety of *mirabilis-gettysburgensis*, Oligocene to Recent in the Pacific as a whole but becoming extinct in California toward the end of the Pliocene before the advance of the first glaciation, and as a variety it may have to take an older name such as *shumardi* or *ashiyaensis*.

The writers are indebted to Mr. Alex Clark of the Shell Oil Company for all the specimens of *semirostrata* and also for the following.

Nucula (Acila) sp.

Text figure 4

Shell smaller than that of *Nucula* (*Acila*) *semirostrata*, with an umbonal angle of about 120°; beaks nearly medial, the anterior end of the shell broadly rounded, the posterior end protruding to an abruptly curved extremity at the ventral margin; sculpture consisting of fine radial riblets divaricating along an approximately laterally medial axis. Dimensions: Length, 23 mm.; height, 18 mm.; convexity of the two valves, about 10 mm.



TEXT FIGURE 4. *Nucula* (*Acila*) sp., specimen No. 374 S. D. S. N. H., from the same locality as the specimens shown in text figures 2 and 3. Exterior of left valve, natural size.

Specimen: S. D. S. N. H. No. 374, both valves.

Locality: S. D. S. N. H. locality 442, found with the preceding species.

The unique specimen figured occurred with the types of *Nucula* (*Acila*) *semirostrata* and it may be a deformed individual of the latter species. This shell differs in its peculiar shape from other Pacific coast described species of *Acila;* but until more specimens are available to prove that it is not a freak or deformed individual, it is better to leave it unnamed. The shape is well shown in the text figure.

Mr. J. L. Ridgeway made the original drawings for text figures 1–4.

Section TRUNCACILA Schenck MS., new section

Type: Nucula castrensis Hinds.

Shell without the shallow sinus characteristic of the typical section of *Acila*, the posterior end being truncated, as a rule, nearly at right angles.

The writers have recognized for some time the desirability of separating sectionally the rostrate from the truncate group of *Acila*. As Dr. Schenck has pointed out that *N. divaricata* Hinds belongs with the rostrate group and may even be an earlier name for *mirabilis*, it appears that it is the *castrensis* group that is in need of a name.[1]

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[1] Although Dr. Schenck believes that all the evidence points to the conclusion that *divaricata* belongs to the rostrate group, he regards the case as not yet absolutely proven. He is now attempting to get more reliable information from the British Museum about the type or topotypes. For this reason, in a paper delivered before the Pacific Section of the Paleontological Society at its meeting in Pasadena, March 7, 1931, he preferred to refer to the two groups merely as the rostrate section and the truncate section, and he now hesitates to publish the new name. However, because the matter is nearly certain and because it will be of value to emphasize the distinction in the present memoir, he has kindly agreed to this prior publication of the name.

Nucula (Acila) castrensis Hinds

Plate 1, Figures *6a*, *6b*

Nucula castrensis Hinds, Proc. Zool. Soc. London, 1843, p. 98; Voy. Sulphur, Zool., p. 63, pl. 18, fig. 5, 1844; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 545, 1858; Hanley, in Sowerby's Thes. Conchyl., Vol. 3, p. 155, pl. 230, fig. 151, 1860; Sowerby in Reeve, Conch. Icon., Vol. 18, *Nucula*, pl. 4, fig. 32, 1870; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 192, 1892; Keep, West Amer. Shells, p. 20, 1904; Gripp, Nautilus, Vol. 22, p. 137, 1909; English, Univ. Calif. Publ. Geol., Vol. 8, p. 213, 1914.

Nucula divaricata Conrad, Amer. Journ. Sci., Ser. 2, Vol. 5, p. 432, figs. *1a*, *1b*, 1848, reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 150, 1909; not *N. divaricata* Hinds, Voy. Sulphur, Moll., p. 62, pl. 18, fig. 4, 1843.

Nucula lyallii Baird, Proc. Zool. Soc. London, p. 71, Feb. 10, 1863; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 605, 1864.

Nucula conradi Meek, Checklist Miocene Foss. N. Amer., p. 27, 1864; not of Dall, U. S. Geol. Surv., Prof. Paper 59, p. 102, pl. 12, figs. 4, 5, 1909.

Nucula lyalli Baird, in Lord's Naturalist in Vancouver, Vol. 2, p. 369, 1866.

Acila castrensis Hinds, Cooper, 7th Ann. Rept. Calif. St. Min., p. 227, 1888 (in part); Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 251, 1916; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 246, pl. 14, figs. 1, 2, 1918; Dall, Proc. U. S. Nat. Mus., Vol. 66, No. 2554, p. 2, pl. 9, fig. 5, 1925.

Nucula (*Acila*) *castrensis* Hinds, E. A. Smith, Journ. Conch., Vol. 7, p. 110, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 95, 1903; Proc. U. S. Nat. Mus., Vol. 34, pl. 37, fig. 5, 1908; Willett, Nautilus, Vol. 32, p. 66, 1918; Dall, Bull. 112, U. S. Nat. Mus., p. 10, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 14, pl. 5, fig. 11, pl. 37, figs. 1, 2, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 2, 1925.

Not "*Nucula* (*Acila*) *castrensis* Hinds," Reagan, Trans. Kansas Acad. Sci., Vol. 22, pp. 174, 175, pl. 1, fig. 2, 1909, *fide* Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 306, 1922.

? Acila muta Clark, Univ. Calif. Publ. Geol., Vol. 11, p. 119, pl. 13, figs. 6, 12, 13, 1918.

Acila empirensis Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 96, pl. 9, figs. 4, 5, 8, 1922.

Shell rather large, moderately thick, trigonal in shape; the posterior end abruptly truncated with a slight alateness below beaks; ventral margin broadly and evenly rounded, becoming more sharply curved at the anterior point of shell; dorsal margin very gently curved, sometimes for a short distance nearly straight in profile; ventricose in middle, variable in degree; hinge with a gently curved anterior row of about 22 or 23 scarcely chevron-shaped, long, sharp teeth, the teeth longest just anterior to the middle of the row and decreasing uniformly in length towards the ends of the row, posterior row much shorter, nearly straight, with about 12 or 13 long sharp teeth, longest in the middle of the row; chondrophore small, elongate, nearly parallel to anterior-posterior axis of shell; inside of valves and teeth pearly, ventral margins not crenulated but a very fine fluting generally visible; exterior of valves sculptured with a divaricating series of radial ribs, the axis of divarication being generally single and located on or near the most ventricose portion of the valves a little posterior to the middle of the shell, the sculpture being variable on different individuals and frequently consisting of a double, or triple, or irregular series of divaricating ribs; concentric sculpture consisting of growth lines generally only on the later-formed portion of the valves or more emphasized there; color dark brown to almost ebony. Measurements (of average mature Recent specimen from Puget Sound): Length, 17 mm.; height, 15 mm.; thickness, about 11 mm.; length, of anterior row of teeth, 10.5 mm.; of posterior row, 5 mm.

Type locality: Sitka, Alaska; Recent.

Miocene: Miocene of Astoria, Oregon (as *N. conradi* Meek); ?Miocene near Blakeley, Washington (Arnold); ?Miocene of Martinez, also of Griswold's, San Benito County, California, and of Oregon (Cooper).

Pliocene: Upper Wildcat beds, northern California (Martin); lower Purisima (English, 1914); rare in *Mya japonica* zone, Etchegoin formation of Coalinga district, lower Fernando, upper Sargent and Purisima (Nomland); Pliocene of San Fernando, Los Angeles County, and of San Diego well, San Diego (Cooper); upper Pico of the clay pits north of Ventura (H. G. Schenck); middle Wildcat; Merced of Sargent oil field, San Benito County; Merced of Año Nuevo Bay (Martin); S. D. S. N. H. Loc. 206, lower Pico of Elsmere Canyon; S. D. S. N. H. Loc. 217a, middle Pico beds near Holser Canyon; S. D. S. N. H. Loc. 225, upper Pico, between Timber Canyon and Santa Paula Creek, Ventura County, several specimens (H. R. Gale, collector); Pliocene or Pleistocene, Coos Conglomerate, Oregon, Howe (as *A. empirensis* Howe).

Pleistocene: "Pliocene" of Deadman Island, common, of Timm's Point, rare; rare in lower San Pedro series of Deadman Island and San Pedro bluffs, Los Angeles County (Arnold); Pleistocene from Santa Barbara to San Diego (Cooper); lower San Pedro of Nob Hill cut, San Pedro (T. S. Oldroyd).

Recent: Bering Sea to San Diego, California (Dall, 1921).

This is the common Recent *Acila* of the Pacific coast. It appears to occur at least as early as the Miocene and is represented by closely related forms in the Oligocene. *Acila muta* Clark from the Oligocene of California, Oregon and Washington, appears very closely related. Conrad's figures of *Nucula divaricata* (Conrad, not Hinds, renamed *conradi* Meek) are puzzling, as the two outlines do not agree in the amount of truncation of the posterior end of the shell. The sculpture, average shape of the two figures, and the occurrence suggest that the true *conradi* is a synonym of *N. castrensis* Hinds. The shell which Dall figures[1] as *A. conradi* Meek is vastly different in shape from that suggested by Conrad's figures, and Howe[2] has very properly recognized this difference and renamed Dall's form *Acila blancoensis*. Howe's *Acila empirensis*[3] is within the range of individual variation of *A. castrensis* and should be considered a synonym.[4]

Acila castrensis (Hinds) differs from *A. blancoensis* Howe in its more abruptly truncate posterior margin.

Nucula (Acila) blancoensis (Howe)

Nucula (*Acila*) *conradi* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 102, pl. 12, figs. 4, 5, 1909 (description and figure, not synonymy, *fide* Howe, 1922); not *Acila conradi* Meek, 1864.
? *Acila conradi* (Meek), Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 417, pl. 62, fig. 4, 1915, *fide* Howe, 1922.
Acila blancoensis Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 95, pl. 9, fig. 3, 1922.

Type specimen: In Stanford University collection.

Type locality: Cape Blanco, Oregon; basal Empire formation, Miocene.

Miocene: Empire beds at Coos Bay; also Miocene of Fossil Point, Oregon (Dall); basal beds of Empire formation, Cape Blanco, Oregon (Howe); possibly upper San Pablo of middle California (*fide* Howe, 1922).

The more rounded posterior end of the shell of this species at once separates it from *A. castrensis*. The specimen classified as "*A. conradi* Meek," by Clark, from the upper San Pablo beds (upper Miocene) of middle California and figured by him in his San Pablo monograph, appears to be somewhat intermediate in shape between *blancoensis* and *castrensis*, but the type specimen is not before us.

Nucula (Acila) ermanni Girard

Nucula ermanni Girard, A. Erman's Archiv. Wiss. Kunde Russland, Vol. 3, p. 545, figs. 8*a*, 8*b*, 1843.
Nucula ermani Girard, Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 353, pl. 5, figs. 1*a*, 1*b*, 1850; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 572, 1895.
Nucula (*Acila*) *ermani* Girard, Dall, 17th Ann. Rept. U. S. Geol. Surv., p. 844, 1896.

Miocene: Atka and St. Paul islands, Alaska (Grewingk; Dall, 1896).[5]

It is not certain whether this species belongs to the typical section of *Acila* or to *Truncacila*.

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[1] U. S. Geol. Surv., Prof. Paper 59, pl. 12, figs. 4, 5, 1909.

[2] Univ. Calif. Publ. Geol., Vol. 14, p. 95, pl. 9, fig. 3, Sept. 8, 1922.

[3] *Op. cit.*, p. 96, pl. 9, figs. 4, 5, 8.

[4] *A. empirensis* has more prominent sculpture than the average *castrensis* but can be matched by specimens of the latter when a large series is available. Packard (Univ. Calif. Publ. Zool., Vol. 14, pl. 14, fig. 1, 1918) figures a specimen with strong sculpture.

[5] Eichwald, p. 126, 1871, notes that this species occurs with *Cardium decoratum* and attributes them both to the Cretaceous. Dall seems to have been influenced by this view in 1895, but in 1896 he reversed his opinion. See the note to *Mya arenaria* variety *profundior*, p. 414.

Family NUCULANIDAE

Like *Nucula*, but posterior end elongate, rostrate; ligament variable in position, often behind the beaks; inner shell layer porcellanous or sub-nacreous; ends of shell sometimes partly gaping.

Geologic range: Ordovician to Recent.

Distribution: World wide.

This family differs from the *Nuculidæ* in the lack of the posterior truncation so characteristic of *Nucula*, in the less pearly or entirely porcellanous inner shell layer, in the sinuate pallial line which is due to the presence of true siphons, and in the development of a ligament.

Most of the species of this family are mud dwellers, those with long posterior rostrums living buried in the mud. The Yoldias are generally thinner shelled than the Nuculanas and are more active in their movements. Many species live in cold waters; but the tropics also have an abundant fauna, including some large forms, such as *Nuculana gibbosa* Sowerby, of Panama Bay, the largest species of the genus.

Some of the Paleozoic genera are with difficulty separated from Recent genera. The family is a primitive prionodont group, the main stock of which has persisted through an immense time interval with little change from the early prototypes.

Nuculana and *Yoldia* are closely related, but the shell of *Yoldia* generally gapes a little at both ends, the keel is more prominent, and the beaks are more apt to be posterior to the center. The pallial sinus of *Yoldia* is deeper than that of *Nuculana*.

Genus NUCULANA Link, 1807

Nuculana Link, Beschreibung der Naturalien-Sammlung der Universität zu Rostock, Abth. 3, p. 155, 1807; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 320, 1871; Meek, U. S. Geol. Surv. Territories, Vol. 9, pp. 103, 104, 1876; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 348, 1897; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 572, 1898; Jukes-Browne, Journ. Conchology, Vol. 11, p. 100, 1904.

Leda Schumacher, Essai Nouv. Syst. Habit. Vers Test., pp. 55, 172, 173, 1817 (pl. 19, fig. 4, "*Arca rostrata* Chemnitz"); Verrill and Bush, Amer. Jour. Sci., Ser. 4, Vol. 3, p. 54, 1897; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 579, 1898; Verrill and Bush, Proc. U. S. Nat. Mus., Vol. 20, p. 854, 1898.

Type (by monotypy) *Arca rostrata* Chemnitz, Neues Syst. Conchyl. Cab., Vol. 7, p. 206, pl. 55, figs. 550, 551, 1784; Montagu, Supplement to Testacea Brit., p. 55, pl. 27, fig. 7, 1808; Recent, northern coasts of Europe.

Nuculanidæ with the posterior end of the shell generally more produced than the anterior end; pallial line only slightly sinuous; valves closed or but slightly gaping.

Geologic range: Paleozoic (Silurian ?) to Recent.

Distribution: World wide; abundant in cold seas.

There has been some difference of opinion in regard to the use of *Nuculana* Link. Some authors, like Dall, have refused to adopt Link's name because it appeared to them to be merely an arbitrary alteration of *Nucula* Lamarck. Such an interpretation, if applied generally, would lead to several undesirable changes and is not in strict accord with the International Code. In enumerating the Rostock collection, Link had but one species, which fortunately fixes the type of *Nuculana* on *rostrata* by monotypy. *Leda* Schumacher, proposed a decade later and based on the same type, is an exact synonym of *Nuculana*.

Several subdivisions of *Nuculana* have been proposed, but it is sometimes difficult to place species in the proper group. The typical *Nuculana* is elongate posteriorly and has sculpture consisting of indefinite growth striæ. *Perrisonata* Conrad[1] is exceedingly elongated, soleniform and smooth. *Lembulus* Risso[2] is subovate, with a lateral median rib on the rostrum of each valve, and the sculpture is strong and oblique. *Jupiteria* Bellardi[3] is Corbuloid and bluntly rostrate. *Adrana* H. and A. Adams[4] is a very elongate, lanceolate form, with a nearly straight dorsal margin. *Sacella* Woodring includes a number of Atlantic and Pacific coast Tertiary and Quaternary species and seems to be a widely distributed group.

Section NUCULANA, s. s.

Very elongate, but not lanceolate; thin; sculpture not prominent.

Nuculana (Nuculana) pernula (Müller)

Mya corrugata Martini, Zwoschalichte Konch. in Besch. Berl. Ges., Vol. 3, p. 297, pl. 7, figs. 17, 18, 1777, not of Müller, *fide* Dautzenberg et Fischer, Moll. Hirondelle et Princesse-Alice, Mers du Nord, p. 396,1912.

Arca pernula Müller, Beschäft. Naturf. Freunde zu Berlin, Vol. 4, p. 55, 1779.

Leda rostrata Schumacher, Essai Nouv. Syst. Vers Test., p. 173, 1817, not of Montagu, 1808.

Arca rostrata Wood, Index Test., p. 47, pl. 10, fig. 43, 1825, not of Montagu, 1808.

Nucula oblonga Brown, Illust. Conch. Gr. Brit. Irel., pl. 25, fig. 17, 1827.

Leda pernula Müller, Lovén, Index Moll. Scand., p. 34, 1846; S. Wood, Crag. Mollusca, pt. 2, p. 93, pl. 10, figs. 13*a-c*, 1850; H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 547, pl. 126, figs. 4*a-b*, 1858; Hanley, in Sowerby's Thes. Conchyl., pl. 3, figs. 56 to 58, 1863; Sowerby, Reeve's Conch. Icon., Vol. 18, pl. 2, figs. 5*a-c*, 1871 (*Læda*); Sars, Moll. Reg. Arct. Norv., p. 35, pl. 5, fig. 1*a-b*, 1878; Tryon, Struct. Syst. Conch., Pt. 3, p. 248, pl. 126, fig. 31, 1884; Verrill and Bush, Proc. U. S. Nat. Mus., Vol. 20, p. 855, pl. 82, fig. 2, 1898; Dall, Canadian Arctic Exped., Vol. 8, pt. A, p. 28A, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 11, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 19, pl. 19, figs. 7, 7*a*, 1924.

Nuculana pernula Müller, Mörch, Cat. Yoldi, Pt. 2, p. 43, 1853; Mörch, Synops. Moll. mar. Daniæ, p. 62, 1871; Dautzenberg et Fischer, Moll. Hirondelle et Princesse-Alice, Mers du Nord, (Monaco), Fasc. 37, p. 396, 1912.

Type locality: North Sea; Recent.

Pliocene: English Crag (S. Wood).

Pleistocene: West side of Coppermine River, five miles from its mouth, Arctic circle, northern Canada (Dall, 1919); Pleistocene of Grinnell Land and northern Greenland (Jeffreys, Ann. Mag. Nat. Hist., Ser. 4, Vol. 20, p. 489, 1877); etc.

Recent: Arctic Ocean to Plover Bay, eastern Siberia; also northern Atlantic.

This species is elongate posteriorly, terminating in a truncated rostrum, the anterior end being regularly curved; the valves are very moderately ventricose and gape slightly behind. The sculpture is reduced to low growth striæ, the exterior of Recent specimens being covered by a thin, pale olive colored epidermis. In comparison with *N. conceptionis* Dall, it is less elongate and higher between the ventral margin and the umbones.

N. pernula (Müller) is a well-known north Atlantic species and is well provided with synonyms. Dautzenberg and Fischer, in the magnificent volume published by the Prince of Monaco referred to above, have given an extensive list of synonyms and references.

Nuculana sadoensis (Yokoyama),[5] a fossil species of the upper horizon, Sawané, (probably upper Pliocene) of Japan, appears to be very similar to *N. pernula*, but Yokoyama's species has a more curved dorsal margin on the rostrum.

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[1] Amer. Jour. Conch., Vol. 5, p. 98, 1869; monotype *P. protexta* Conrad, Eocene (?) of Haddonfield, New Jersey.

[2] Hist. Nst. Eur. Mérid., Vol. 4, p. 319, 1825; type *L. rossianus* Risso = *Arca pella* Linnæus, *fide* Bucquoy, Dautzenberg et Dollfus, Moll. Mar. Roussillon, Tome 2, fasc. 5, p. 218, pl. 37, figs. 32-35, 1891.

[3] Monog. Nucul. Terziari Piemonte e della Liguria, p. 20, 1875, *fide* Woodring, Carnegie Inst. Publ. No. 366, p. 18, 1925.

[4] Gen. Rec. Moll., Vol. 2, p. 547, 1858, type *N. lanceolata* Lamarck (*taylori* of Hanley).

[5] Journ. Faculty of Sciences, Imp. Univ. Tokyo, Section 2, Vol. 1, No. 8, p. 308, pl. 36, fig. 6, 1926.

Nuculana (Nuculana) conceptionis (Dall)

Leda conceptionis Dall, Nautilus, Vol. 10, p. 2, May, 1896; Nat. Hist. Soc. Brit. Columbia, Bull. No. 2, p. 7, pl. 2, fig. 1, Jan. 1897; U. S. Nat. Mus., Bull. 112, p. 12, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 21, pl. 39, fig. 1, 1924.

Type specimen: In U. S. National Museum.

Type locality: Off Point Conception, California, *fide* Oldroyd, 1924.

Pliocene: Questionably in the upper Etchegoin (upper Pliocene) of the Federal Exploration Company well, Kinsella No. 1 (depth 2680 feet), near Tipton, Tulare County, California, one specimen (H. R. Gale).
Recent: Aleutian Islands to San Diego, California (Dall, 1921).

Nuculana conceptionis (Dall) differs from *N. pernula* (Müller) in its more attenuated form. It is uncommon in collections, perhaps because of its habitat in deeper waters off shore. A single imperfect specimen from the Etchegoin of the well near Tipton appears to be of this species.

Nuculana fossa (Baird)

Leda fossa Baird, Proc. Zool. Soc. London for 1863, p. 71, 1863; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 644, 1864; Newcombe, Nautilus, Vol. 10, no. 2, p. 19, June, 1896; Dall, Nat. Hist. Soc. Brit. Columbia, Bull. No. 2, p. 7, pl. 2, figs. 3, 13, Jan. 1897; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 96, pl. 17, fig. 7, 1903; Dall, Wash. Acad. Sci., Alaska, Repts. Harriman Alaska Exped., Vol. 4, p. 121, 1904, reissued by Smithsonian Inst., 1910; Willett, Nautilus, Vol. 32, no. 2, p. 66, 1918; Dall, U. S. Nat. Mus., Bull. 112, p. 11, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 19, pl. 5, fig. 6, 1924.

Type locality: Vancouver Island, British Columbia.

Pleistocene: Lower San Pedro series of Deadman Island, San Pedro, one specimen (Arnold, 1903); Pleistocene of Douglas Island, near Juneau, Alaska (Dall, 1910).
Recent: Alaska to Puget Sound.

This species is much more ventricose and has stronger concentric sculpture than either *N. pernula* or *N. conceptionis.* It appears to be a first step from *Nuculana, s. s.,* toward section *Sacella* Woodring. The dorsal area back of the umbones is quite broad and flat and but little if any pouted where the two valves meet.

Section SACELLA Woodring, 1925

Ledina Sacco, I. Molluschi dei Terreni Terziarii del Piemonte e della Liguria, Pt. 26, p. 53, Dec., 1898; not *Ledina* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 580, April, 1898, type, *L. eborea* Conrad, 1860 (not Conrad, 1846) = *L. smirna* Dall, Eocene, Gulf coast, U. S. A.
Sacella Woodring, Carnegie Inst. Publ. No. 366, p. 15, May 20, 1925, new name for *Ledina* Sacco, not *Ledina* Dall.

Type (by original designation, Sacco), *Arca fragilis* Chemnitz (= *Leda commutata* Philippi), Miocene to Recent, Mediterranean Sea, *fide* Woodring, 1925.

Shell small, high, slightly inequilateral, posterior end rostrate, rostrum sharply pointed and unicarinate; a shallow groove extending from the umbo to the ventral margin at both ends of the valve; sculpture consisting of strong concentric rugæ; hinge like that of *Nuculana, s. s.,* but with the anterior and posterior series of teeth approximately equal in length; apex of pallial sinus broadly u-shaped. (Woodring, 1925.)

Geologic range: Tertiary (Cretaceous ?) to Recent.

Distribution: Widely distributed.

Sacella Woodring, used *sensu lato,* appears to include most of the Pacific coast Tertiary Nuculanas. *Lembulus* Risso is somewhat similar, but has radial ribs on the rostrum and the sculpture is oblique to the growth lines.

Nuculana taphria (Dall)

Plate 1, Figures 8, 9

Nucula cælata Hinds, Proc. Zool. Soc. London for 1843, p. 99, Dec., 1843; Zool. Voy. Sulphur, p. 64, pl. 18, fig. 13, 1844.

Leda cælata Hinds, Hanley, Thes. Conchyl., Vol. 3, *Nuculidæ*, p. 129, pl. 228, figs. 95, 96, 1860; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 644, 1864; Sowerby in Reeve, Conch. Icon., Vol. 18, *Leda*, sp. 6, pl. 2, figs. 6*a*, 6*b*, 1871; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 103, 1868; Cooper, 7th. Ann. Rept. Calif. State Mineralogist, p. 245, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 192, 1892; Dall, Nautilus, Vol. 10, p. 70, Oct., 1896; not *Nucula coelata* Conrad, 1833, Claiborne Eocene.

Leda taphria Dall, Nautilus, Vol. 10, no. 6, p. 70, Oct., 1896; Dall, Nat. Hist. Soc. Brit. Columbia, Bull. No. 2, p. 7, pl. 2, figs. 6, 8, Jan., 1897; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 98, pl. 17, fig. 5, 1903; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, pl. 38, figs. 3, 3*a*, 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 544, pl. 48, figs. 5, 5*a*, 1907; Smiths. Misc. Coll., Vol. 50, Pt. 4, p. 26, pl. 55, figs. 3, 3*a*, 1907; Proc. U. S. Nat. Mus., Vol. 34, pl. 35, fig. 6, 1908; T. S. Oldroyd, Nautilus, Vol. 28, p. 82, 1914; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Martin, Vol. 9, p. 252, 1916; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 248, pl. 14, figs. 7*a*, 7*b*, 8, 1918; Dall, U. S. Nat. Mus., Bull. 112, p. 10, 1921; Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 141, 1922; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 148, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 16, pl. 37, figs. 7, 7*a*, 8, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 3, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: Of *taphria*, in U. S. National Museum.

Type locality: California; Recent.

Miocene: Questionably credited in the Briones, and in the Monterey group (Trask, 1922).

Pliocene: Pliocene of San Fernando, of Elsmere, Holser and Pico canyons (Arnold; English); middle Pliocene west of Fernando Pass, S. D. S. N. H. Loc. 213; upper horizon, middle Pliocene, Elsmere Canyon, S. D. S. N. H. Loc. 201*a*; Pliocene near Holser Canyon, S. D. S. N. H. Loc. 217*b*; (coll. by H. R. Gale); San Diego formation of Reynard Way, San Diego (coll. by Frank Stephens); Pliocene of Pacific Beach, San Diego (Arnold); San Diego Well (Cooper); Purisima formation of middle California; middle Wildcat formation of northern California (Martin); Santa Barbara formation, upper Pliocene at Bath-house Beach, Santa Barbara (Arnold).

Pleistocene: "Pliocene" of Deadman Island and Timm's Point, San Pedro district (Arnold); lower and upper San Pedro series of San Pedro and vicinity (Arnold); Pleistocene of Signal Hill (Arnold; T. S. Oldroyd); Tomales Bay, Marin County (Dickerson); Pleistocene of Pacific Beach and of Spanish Bight, San Diego (Arnold; Mrs. K. Stephens, MS.); lower Quaternary at Magdalena Bay, and upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan).

Recent: Bodega Bay, California, to Lower California, Mexico (Dall, 1921).

Nuculana taphria (Dall) is readily recognized by its very uniform, prominent, concentric sculpture, its nearly central umbones, the bluntly-pointed rostrum and the well-defined, somewhat depressed area posterior to the umbones. Most specimens show a very shallow sinus on each valve radiating from near the umbones to the ventral margin just anterior to the end of the rostrum. This feature is variable in strength. The two gently curving rows of chevron-shaped teeth are unequal in length, the posterior being the shorter. There is some variation in shape, size, and ventricosity, but the uniform, rather strong concentric sculpture is quite characteristic. The average mature specimen measures about 7 mm. in length by 5 mm. in height.

"*Leda*" *pontonia* Dall, a Recent species of the Pacific coast ranging from California to Peru, has somewhat the shape of *taphria*; but the sculpture is not so strong, the dorsal area over the rostrum is somewhat pouted in the middle, and the margins are not set off by a ridge.

Nuculana astoriana (Henderson), from the Empire formation of Oregon, is a closely related form, but is much more elongate and the sculpture appears to be obsolete near the umbones. *N. confusa* (Hanley) from Japan is sculptured like *taphria*, but a Pleistocene specimen kindly sent by Professor H. Yabe is thinner shelled, less ventricose, less curved over the rostrum, and the dorsal areas are narrower.

Nuculana astoriana (Henderson)

Plate 32, Figures 46, 47, 48

Nucula impressa Conrad, Geol. U. S. Expl. Exped., p. 726, pl. 18, figs. 7*a-e*, 1849, not of Sowerby, 1825, nor of Hall, 1845.

Yoldia impressa Conrad, Amer. Jour. Conch., Vol. 1, p. 154, 1865; Arnold, Proc. U. S. Nat. Mus., Vol. 34, pl. 35, fig. 3, 1908; not "*Yoldia impressa* Conrad" of Reagan, *fide* Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 306, 1922, = *Yoldia reagani* Dall.

Yoldia (*Portlandia*) *impressa* Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 105, 106, 1909.

Yoldia astoriana Henderson, Nautilus, Vol. 33, p. 122, 1920, new name for *Nucula impressa* Conrad, 1849, not *N. impressa* Sowerby, 1825, nor of Hall, 1845.

Leda subimpressa Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 97, pl. 10, fig. 3, 1922.

Yoldia (*Portlandia*) *astoriana* Henderson, Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 185, 1924.

Type specimen: In U. S. National Museum.

Type locality: Miocene of the Astoria group, Astoria, Oregon (Dall, 1909).

Miocene: Astoria Miocene, Astoria, Oregon (Dall, 1909); Empire formation, Coos Bay, Oregon (Dall; Howe); Monterey (middle Miocene) formation of Santa Cruz County, California (Arnold, 1908).

This species appears to be an elongate *Nuculana* with concentric sculpture confined to the portions of the valves away from the umbones. Conrad's original figures are significant and are more suggestive of *Nuculana* than *Yoldia*. Howe's *Leda subimpressa* is identical in shape with Conrad's figures in the atlas to the geology of the Exploring Expedition, and the characters of the shallow radiating sinus on the sides of the shell near the posterior truncation are not considered reliable for specific differentiation in this group. *N. taphria* shows variation in this latero-posterior sinus not correlated with age or habitat.

The "*Yoldia impressa* Conrad" of Reagan[1], from the Clallam formation of Washington, was renamed *Yoldia reagani* by Dall,[2] who believed it to be a distinct species.

Nuculana minuta (Fabricius) subspecies **præcursor** (Arnold)

Leda minuta Fabr. var. *præcursor* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 97, pl. 17, fig. 6, 1903.

Type specimen: In U. S. National Museum.

Type locality: Deadman Island, San Pedro, California; lower Pleistocene.

Pleistocene: "Rare in lower San Pedro series of Deadman Island and San Pedro" (Arnold).

Arnold stated that this form was "distinguishable from *L. taphria* by smaller size, truncated posterior end with process on interior at this end, comparatively coarser sculpture, straighter posterior dorsal margin, and fewer teeth." The dimensions given by Arnold were as follows: Long. 7.8 mm.; alt. 5 mm.; diam. 3.9 mm.; umbo to posterior end 5 mm.; to anterior end 4 mm.

From Arnold's figure, *præcursor* appears to be less elongate than *minuta*, with less attenuated rostrum and coarser sculpture. We have seen no specimens. Figures of *minuta*, *s. s.*, from Hanley's monograph in the Thesaurus Conchyliorum are reproduced herewith, plate 1, figures 2*a*, 2*b*.

Nuculana cellulita (Dall)

Leda cellulita Dall, Nautilus, Vol. 10, p. 1, May, 1896; Dall, Nat. Hist. Soc. Brit. Columbia, Bull. No. 2, p. 7, pl. 2, figs. 5, 7, Jan., 1897; U. S. Nat. Mus., Bull 112, p. 10, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 6, pl. 1, fig. 7, March, 1924; Stanford Univ. Publ. Geol., Vol. 1, pp. 16, 17, pl. 5, fig. 7, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 3, 1925.

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[1] Trans. Kansas Acad. Sci., Vol. 22, p. 177, pl. 1, fig. 4, 1909.

[2] Amer. Jour. Sci., Ser. 5, Vol. 4, p. 306, 1922.

Type specimen: In U. S. National Museum.

Type locality: Puget Sound; Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill, San Pedro, California (T. S. Oldroyd).
Recent: Puget Sound (Dall, 1921).

This species is less elongate and more bluntly pointed posteriorly than *taphria*. The sculpture is not quite coincident with the growth lines.

This species and some of the following may not belong to the section *Sacella*.

Nuculana acuta (Conrad)

Nucula acuta Conrad, Amer. Marine Conch., p. 32, pl. 6, fig. 3, 1832; Conrad, Foss. Medial Tert. United States, p. 57, pl. 30, fig. 2, 1845; Tuomey and Holmes, Pleiocene Foss. S. Carolina, p. 53, pl. 17, figs. 10-12, 1857 (as of "Say"); not *Nucula acuta* Sowerby, Trans. Geol. Soc. London, Ser. 2, Vol. 5, pl. 39, fig. 5, 1837.

Leda unca Gould, Proc. Boston Soc. Nat. Hist., Vol. 8, p. 282, 1862; Verrill, Trans. Conn. Acad. Arts. Sci., Vol. 5, p. 572, pl. 58, fig. 41, 1882.

Nuculana acuta Conrad, Acad. Nat. Sci. Phila., Proc. for 1862, p. 581; Meek, Miocene Checklist, Smiths. Misc. Coll., Vol. 7 (No. 183), p. 5, 1864.

Leda acuta Conrad, Verrill, Trans. Conn. Acad. Arts. Sci., Vol. 6, p. 259, pl. 30, fig. 15, 1884; Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 18, p. 438, 1889; U. S. Nat. Mus., Bull. 37, p. 44, pl. 7, figs. 3*a*-*b*, pl. 45, fig. 15, pl. 64, fig. 140, 1889; Trans. Wagner Inst. Sci., Vol. 3, pt. 4, pp. 592, 593, 1898; Clark, Maryland Geol. Surv., Pliocene and Pleistocene, p. 208, pl. 65, figs. 5-8, 1906; Dall, Bull. 112, U. S. Nat. Mus., p. 10, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 7, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 16, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Gardner, U. S. Geol. Surv., Prof. Paper 142A, pt. 1, p. 12, pl. 2, figs. 13-16, 1926.

Leda (*Lembulus*) *acuta* Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 103, 1909.

Type specimen: In N. Y. State Museum, Albany, N. Y., or Academy of Natural Sciences, Philadelphia, Pa., *fide* Oldroyd, 1924.

Type locality: Atlantic Ocean, off North Carolina.

Miocene: "Miocene of uppermost beds at Fossil Point, Coos Bay, Oregon" (Dall, 1909); Miocene of Virginia, North and South Carolina and Florida (Gardner, 1926).
Pliocene: Virginia, North and South Carolina, and Florida (Gardner).
Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926); Pleistocene of Maryland, North and South·Carolina, and Florida (Gardner, 1926).
Recent: Nazan Bay, Atka Island, Aleutians to Gulf of California; also Atlantic.

This widely distributed species is recognizable by its rather uniform concentric sculpture, by its small size, and by the almost straight dorsal margin of the rostrum. A shallow radiating depression or sulcus extends from the umbonal area to the ventral margin anterior to the medial portion of the valves. The position and strength of this depression are rather variable, the depression being nearly or even quite obsolete on some specimens. A similar radial depression is shown on most Pacific coast specimens just anterior to (or below) and parallel to the dorsal margin of the rostrum. The Recent specimens from San Pedro are less elongate than the Recent Atlantic and the Florida Miocene forms, but the differences do not seem sufficient for varietal separation. A few Recent specimens from San Pedro have the rostrum abruptly, almost vertically, truncated, but they are exceptional and grade into the more common, acutely terminated form.

N. acuta differs from *N. penderi* in its smaller size and its less dorsally curved rostrum. Dall and Bartsch, in their description of *N. penderi,* state that the latter is less elongate than *acuta*, a relationship which is true of the Atlantic *acuta*, but does not hold for the shorter, less typical Pacific coast representatives of Conrad's species.

"*Leda gabbi* Conrad," as figured by Dickerson[1], has a strong resemblance to some of the Atlantic variants of *Nuculana acuta* (Conrad). Gabb's figure[2] of "*Leda protexta ?*" (from California, renamed *gabbi* by Conrad) has a greater curve to the dorsal margin of the rostrum than is indicated in Dickerson's illustration, which may represent a different species.

Nuculana penderi (Dall and Bartsch)

Leda penderi Dall and Bartsch, Canada Dept. of Mines, Geol. Surv. Branch, Mem. No. 14-N, p. 9, pl. 1, figs. 3, 4, 1910; Willett, Nautilus, Vol. 32, no. 2, p. 66, 1918; Dall, U. S. Nat. Mus., Bull. 112, p. 11, Feb., 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, pp. 17-18, pl. 39, figs. 4, 5, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 148, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In U. S. National Museum.

Type locality: Barkley Sound, Vancouver Island, British Columbia.

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, and upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1924, 1926).

Recent: Queen Charlotte Islands, British Columbia to Santa Barbara Islands, California (Dall, 1921); Forrester Island, Alaska (Willett).

This species is somewhat larger than *N. acuta* (Conrad) and the dorsal margin of the rostrum is curved more than in Conrad's species. The Pacific coast specimens of *acuta* are less ventricose, but are not more elongate than *penderi*, and it is possible these two shells are closely related. The original measurements of *penderi* are: length of average adult 9.2 mm.; of beaks behind the anterior margin, 4.2 mm.; maximum height, 6.0 mm.; maximum diameter, 5.0 mm. "Some specimens are proportionately less inflated."

Nuculana penita (Conrad)

Nucula penita Conrad, Amer. Jour. Sci., Ser. 2, Vol. 5, p. 433, fig. 10, 1848, reproduced by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 151, fig. 10, 1909.

Neilo penita Conrad, Amer. Jour. Conch., Vol. 1, p. 153, 1865.

Leda penita Dall, U. S. Geol. Surv., Prof. Paper 59, p. 103, 1909.

Type specimen: Probably lost (*fide* Dall, 1909).

Type locality: "Tertiary deposits on the Columbia River, near Astoria," Oregon (Conrad).

Miocene: Astoria group, Astoria, Oregon (Dall, 1909).

This is an early named species. Although based on a cast, its identification from topotypes may be possible. Unfortunately Conrad's type is apparently lost, but his figure depicts a small *Nuculana* with beaks rather near the anterior end of the shell, and collections from the type locality may permit establishing the species from better material. It is likely that *penita* has been confused with *acuta*, but the positions of the beaks should permit distinction of the two species. Some immature individuals of *Nuculana fossa* (Baird) slightly resemble Conrad's figure of *penita*.

Nuculana whitmani (Dall)

Leda (Lembulus) whitmani Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 103, 104, pl. 14, fig. 4, 1909; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, and table opposite, 1922.

Type specimen: In U. S. National Museum, No. 153,970.

Type locality: Fossil Point, Coos Bay, Oregon; Miocene.

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[1] Univ. Calif. Publ. Geol., Vol. 9, pl. 36, fig. 3, 1916; Eocene.

[2] Geol. Surv. Calif., Palæo., Vol. 1, pl. 26, fig. 185, 1864.

Miocene: "From Miocene matrix inclosed as a pebble in the Pleistocene Coos Conglomerate, Fossil Point, Coos Bay, Oregon" (Dall); Empire formation east of Fossil Rock, Oregon (Howe).

Dall described this species from a fragment of a single valve. His figure shows the heavy rostrum which terminates in a blunt, almost vertically truncated end. The sculpture is fine, uniform, and concentric. Some of the variants of *N. minuta* (Fabricius) closely resemble Dall's figure and the similarity may mean a relationship. Dall's original measurements are: "Length of remaining portion of valve, 23 mm.; length from beak to posterior end, 16 mm.; height, 17 mm.; double diameter of valve, 8 mm." Howe states that specimens of this species have been found that are twice as large as that figured by Dall. He also brings up the question of whether it should be assigned to "*Leda*" or to "*Yoldia*." Unfortunately, Howe did not refigure the species.

Nuculana oxia (Dall)

Leda oxia Dall, Proc. U. S. Nat. Mus., Vol. 52, p. 395, 1916; Bull. 112, U. S. Nat. Mus., p. 11, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 18, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In U. S. National Museum, No. 214,848.

Type locality: Off Santa Rosa Island, California, in 48 fathoms, mud.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan).
Recent: Santa Rosa Island, California, to Gulf of California (Dall).

This is a small unfigured species.

Nuculana orcutti (Arnold)

Leda orcutti Arnold, Smiths. Misc. Coll., Vol. 50, Pt. 4, pp. 17, 18, pl. 55, fig. 9, 1907.

Type specimen: In U. S. National Museum, No. 165,271.

Type locality: Waldorf asphalt mine, three miles southeast of Guadalupe, Santa Barbara County, California; Pliocene.

Pliocene: "Fernando formation, lower Pliocene portion," at Waldorf asphalt mine, Santa Barbara County, California (Arnold).

This little species is characterized by its coarse, widely spaced concentric riblets. The umbones are nearly in the center of the dorsal margin, both anterior and posterior dorsal margins being approximately equal in length and nearly straight. The rostrum is not attenuated and comes to a blunt point.

Nuculana hamata (Carpenter)

Plate 1, Figures 14, 15

Leda hamata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 98, 130, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 210, Feb., 1866; Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 558, pl. 40, fig. 9, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 97, pl. 17, fig. 4, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 11, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 23, pl. 6, fig. 4, pl. 37, fig. 5, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 3, 1925.

Type specimen: In British Museum.

Type locality: Santa Barbara, California; Recent.

Pleistocene: "Pliocene" and lower San Pedro series of Deadman Island, Los Angeles County, rare (Arnold); Pleistocene of Spanish Bight, San Diego (Arnold)
Recent: Puget Sound to Panama Bay (Dall)

This strongly concentrically sculptured little species can be immediately recognized by its long, attenuated rostrum (posterior extension), which is squarely truncated at the end. The posterior, gently curved dorsal margin is much longer than the anterior.

A number of species of "*Leda*" have been described from the earlier Tertiary of the Pacific coast. Some of the Miocene ones are noted here, as they may be closely related to Pliocene species. "*Yoldia*" *newcombi* Anderson and Martin,[1] from the "Lower Miocene of Clallam County, Washington," is a *Nuculana* of the typical section, somewhat resembling *N. conceptionis* Dall, but is more attenuated. "*Leda*" *ochsneri* of the same authors, from the lower Miocene of Kern River, Kern County, California, is closely related to *N. taphria*, as suggested in the original description. "*Leda*" *cahillensis* Arnold[2] likewise belongs to *Sacella*. "*Leda*" *chehalisensis* Weaver[3] from the Chehalis formation of western Washington, and "*Leda*" *furlongi* Trask,[4] of the Briones formation of California, appear to be closely related; they probably belong likewise to *Sacella* Woodring. "*Leda*" *willamettensis* Shumard, from the Miocene of the Willamette Valley, Oregon, has not been figured, but as it is an early described species and might be recognized from topotype material, Shumard's description is reproduced below in full.

Nuculana willamettensis (Shumard)

Leda willamettensis Shumard, Trans Acad. of Sci. of St. Louis, Vol. 1, p. 121, 1858, no figure; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 104, 1909.

"Shell small, oblong-ovate, convex, inequilateral; buccal margin gently arched, and forming with the cardinal margin nearly a right angle; anal side prolonged, rostrated, truncated at the extremity; basal margin slightly arched; cardinal border oblique in advance of the beak and slightly excavated behind; beaks sub-medial not very prominent. The surface markings are entirely obliterated on the only specimen we have obtained of this species.

"Form. & Loc.—Occurs with *Lucina parilis* in dark-gray silicious limestone at Brooks' Lime Quarry, Willamette Valley, five miles north of Salem, Oregon Territory." (Shumard, 1858.)

Shumard gave no measurements nor figures, and according to Dall the type is lost.

Genus YOLDIA Möller, 1842

Yoldia H. P. C. Möller, Index Molluscorum Groenlandiæ, p. 18, 1842; Stoliczka, Mem. Geol. Surv. India, Palaeontologia Indica, Vol. 3, p. 320, 1871; Meek, U. S. Geol. Surv. Territories, Vol. 9, p. 107, 1876; Verrill and Bush, Amer. Jour. Sci., Ser. 4, Vol. 3, p. 55, 1897; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 594, 595, 1898; Woodring, Carnegie Inst. Publ., No. 366, p. 21, 1925.

Type (see below): *Nucula arctica* Gray, Supplement to the Appendix Parry's First Voyage, 1819-20, p. 241, 1824; circumboreal; figured herewith, plate 1, figures 10, 11.

Geologic range: Carboniferous to Recent.

Distribution: World wide.

Yoldia and *Nuculana* are closely related, but *Yoldia* can generally be differentiated by its strong keel on the posterior dorsal margin, by its gape at both ends, and by the somewhat thinner shell. *Sacella* Woodring is quite different from *Yoldia, s. s.*, but *Nuculana, s. s.*, is a close approach to the *Yoldia myalis* Couthouy group. *Yoldia* has a deeper pallial sinus than *Nuculana*, but this character is not visible on most fossil specimens.

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[1] Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 54, pl. 3, fig. 2, 1914.

[2] Proc. U. S. Nat. Mus., Vol. 34, p. 375, pl. 34, fig. 9, 1908, lower Miocene of Santa Cruz Quadrangle, Calif.

[3] Washington Geol. Surv., Bull. 15, p. 56, pl. 12, figs. 104, 105, 1912.

[4] Univ. Calif. Publ. Geol., Vol. 13, p. 147, pl. 1, figs. 1*a*-*b*, 1922.

There has been some confusion concerning the type of *Yoldia*. Möller based the genus on two species: "*Y. arctica*, *Nucula arctica* Gray" and "*Y. angularis* nob., *Nuc. myalis* Couth.?" (p. 19). Only these two species, or their specific equivalents, are available as genotypes. Gray (1847) failed to designate a type and the type designations of Stoliczka (1871, "type, *Y. lanceolata* Sow.") and of Verrill and Bush (1897, "Type *Y. hyperborea* Torell") cannot be accepted under the present rules of nomenclature. "*Nuc. myalis* Couth.?" is not available alone as generic type, it being a *species inquirenda*. Dall (1898, pp. 594, 595) assumed that "*Y. hyperborea* (Lovén MS.) Torell" was probably equivalent to the *Yoldia arctica* Gray of Möller and designated *hyperborea* as type. This designation is questionable. Woodring (1925) stated that the type is "*Nucula arctica* Möller not Gray (= *Nucula myalis* Couthouy)." Since Möller considered his *Yoldia arctica* to be actually Gray's *Nucula arctica*, then, if Möller's first species is to be the type, it must be the *Nucula arctica* of Gray, regardless of what species Möller had before him. Unfortunately, the confusion does not end here, for Gray did not figure his species and there is some doubt about its recognition. In a paper on the mollusca of the Bergen fiords, Norman[1] gives a list of references and synonymy under *Yoldia arctica* (Gray) which appears to have been carefully thought out. According to Norman's synonymy *Nucula arctica* Gray (1824) (but not of Möller, Mörch, Sars earlier papers, nor of Broderip and Sowerby, *fide* Torell) is equivalent to: *Nucula truncata* Brown;[2] *Arca glacialis* W. Wood, and of Hisinger; *Nuculana glacialis* Mörch; *Yoldia glacialis* Gray (but not *Arca glacialis* Gray,[3] which is a large Arctic form of *Arca obliqua* Philippi); *Nucula portlandica* Reeve;[4] questionably *N. portlandica* Hitchcock; *Nucula siliqua* Reeve;[5] *Yoldia arctica* of Torell;[6] *Yoldia arctica* of M. Sars;[7] *Yoldia glacialis* of Reeve;[8] and *Leda arctica* of Jeffreys.[9] The figures in the works referred to illustrate what it is reasonable to believe is the form which Gray named "*Nucula*" *arctica*.

In a recent paper on the systematics, ecology, and distribution of *Yoldia arctica* Gray, Mossevitch[10] discusses the variations of this troublesome species and figures the typical form and some of its variants. According to Mossevitch, this species varies considerably in different environments. The variability of this species, which happens to be the genotype, casts doubt on the systematic value of minor subdivisions of the genus *Yoldia*. Two of Mossevitch's illustrations of typical *Yoldia arctica* are reproduced herewith, plate 1, figures 10, 11.

Portlandia Mörch[11] is probably best considered a synonym of *Yoldia*, *s. s.* *Megayoldia* Verrill and Bush[12] is doubtfully distinct, although *Y. thraciæformis* (Storer)[13] is a large form with a rather unique shape representing an extreme development. A specimen of *Y. thraciæformis* from Puget Sound is figured herewith, plate 1, figures 12*a*, 12*b*. *Cnesterium* Dall[1] includes the Yoldias with concentric sculpture not coincident with the incremental lines over all the exterior surface of the valves. *Orthoyoldia* Verrill and Bush[2] includes the Yoldias with a soleniform or elongate-elliptic shape.

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[1] "The Mollusca of the Fiords near Bergen, Norway," Jour. of Conchology, Vol. 2, p. 39 1879.

[2] Illust. Conch. Gt. Brit. Irel., Ed.1, pl. 25, fig. 19, 1827; Ed. 2, p. 84, pl. 33, fig. 19, 1844.

[3] Suppl. Parry's Voy.

[4] Last of the Arctic Voyages (H. M. S. Assistance, narrative by Capt. Belcher), Vol. 2, p. 396, pl. 33, figs. 4, a, b, 1855.

[5] *Op. cit.*, pl. 33, figs. 4a. b.

[6] Bidrag till Spitsbergens Molluskfauna, Stockholm, p. 25, 1859.

[7] Om de i Norge forekommende fossile Dyrelevninger fra quartaerperioden, et bidrag til vor Faunas historie, etc., Christiania, p. 37, pl. 2, figs. 59-66, pl. 3, figs. 67-74, 1865.

[8] Conch. Icon., Vol. 18, *Yoldia*, pl. 3. figs. 12a-b, 1871.

[9] Ann. Mag. Nat. Hist., Ser. 4, Vol. 20, p. 238, 1877.

[10] Académie des Sciences de l'Union des Républiques Soviétiques Socialistes, Matériaux de la Commission pour l'Étude de la République Autonome Soviétique Socialiste Iakonte, Liv. 19, Beiträge zur Systematik, Ökologe und Verbreitung der Recenten und Fossilen Yoldia arctica Gray, pp. 1-44, pl. 1, 1928. (In Russian, résumé in German).

[11] Prodromus Faunæ Moluscorum [*sic*] Grönlandiæ; Fortegnelse over Grönlands Blöddyr; in H. J. Rink, Grönland geographisk og statistisk beskrevet, Band 2, Pt. 4, p. 21, 1857. Type, according to Verrill and Bush (1897), = *P. arctica* (Gray).

[12] Amer. Jour. Sci., Ser. 4, Vol. 3, p. 55, fig. 17, 1897, "Type *M. thraciæformis* (Storer)," by original designation.

[13] Boston Journal Nat. Hist., Vol. 2, p. 122, 1838.

The group represented by *Yoldia cooperi* Gabb, of the California Recent fauna, is somewhat unique in its spatulate shape and very posterior umbones, and we have therefore erected for it the new section *Kalayoldia*.

Section Kalayoldia, new section

Like *Yoldia*, *s. s.*, but posterior dorsal margin of shell curved, concave upward, typically much shorter than anterior dorsal margin; posterior portion of valves rostrate, typically somewhat narrowed vertically; sculpture consisting of definite concentric riblets; hinge with a long, gently curved anterior row of teeth, separated by a relatively large, shallow, ovate ligamental pit from the very short, nearly straight posterior row of teeth; pallial sinus large and deep.

Type: Yoldia cooperi Gabb, Proc. Calif. Acad. Sci., p. 189, 1865; Geol. Surv. Calif., Palæo., Vol. 2, p. 31 in part only, pl. 9, fig. 54, 1866.

Geologic range: Miocene to Recent.

The short and tenuous, recurved, posterior portion of the valves of this group serve to differentiate it from the other sections of *Yoldia*. The type is the well-known Recent species, *Yoldia cooperi* Gabb, (1865, only in part Gabb 1866), which occurs as a fossil in the Pliocene and Pleistocene, and probably in the Miocene.

Yoldia cooperi Gabb

Plate 1, Figure 13; Plate 14, Figure 3

Yoldia cooperi Gabb, Proc. Calif. Acad. Sci., Vol. 3, p. 189, 1865; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 31 in part only, pl. 9, fig. 54, 1866; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 192, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 594, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 99, 1903; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 105, 1909; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 206, pl. 4, fig. 34, 1909 (questionably *Y. cooperi* of Gabb, 1865); English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Nomland, Vol. 9, p. 203, 1916; Martin Vol. 9, pp. 243, 245, 1916; Nomland, Vol. 10, p. 212, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, no. 2, p. 248, pl. 14, fig. 9, 1918; Dall, Bull. 112, U. S. Nat. Mus., p. 13, 1921; Amer. Jour. Sci., Ser. 5, Vol. 4, p. 310, 1922; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, and table opposite, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 30, pl. 1, fig. 1, pl. 37, fig. 9, 1924; Clark, Univ. Calif. Publ. Geol., Vol. 15, p. 78, pl. 8, fig. 6, 1925.

Not *Yoldia cooperi* Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 31 in part, 1866; doubtfully of Reagan, 1909, *fide* Dall, 1922; in part of Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92 and table opposite, 1922.

Shell large, rather flat, greatest height (distance between dorsal and ventral margins) anterior to the median line of the shell and far anterior to the umbones; anterior portion of valves broadly, evenly curved; posterior portion attenuated, produced into a rostrum concavely curved on its dorsal margin; posterior dorsal area somewhat depressed, definitely set off from adjacent surface of valves; umbones posterior, about one-third of the total length of the shell from the posterior end; anterior dorsal margin curving gently into the regular anterior curve. Hinge a long, gently curving, anterior row of rather long, somewhat upcurved teeth, chevron-shaped at their bases, a depressed, somewhat roundly-trigonal ligament pit, and a short, slightly-curved anterior row of teeth. Pallial sinus deep, u-shaped. Sculpture of concentric lamellæ, occasionally slightly irregular in respect to incremental lines on portions of the valve but not regularly oblique. A large Recent specimen from Santa Cruz, California, in the Stanford collection, measures as follows: Total length, 76 mm.; umbo to end of rostrum 26 mm.; umbo to anterior margin of valve, 53 mm.; height (greatest dorsal-ventral distance), 37 mm.; thickness of one valve, about 7 mm.

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[1] Trans. Wagner Inst. Sci., Vol. 3, p. 595, 1898, "Type *Y. arctica* Brod. and Sby., Zool. Journ., 1829; (not of Gray, Parry's Voy. App., 1824) = *Y. scissurata* Dall."

[2] *Op. cit.*, 1897, p. 55, "Type *Orthoyoldia scapina* (Dall)."

Type specimen: In University of California Collection, No. 30,613.

Type locality: Santa Cruz, California; Recent.

Miocene: San Pablo and Santa Margarita formations, upper Miocene (Nomland, 1917); "known Miocene" (Howe, 1922), [see discussion below]; Quillayute, Washington (Reagan).

Pliocene: Merced-Purisima Pliocene of middle California (Martin); Etchegoin, lower Pliocene on Jacalitos Creek and Waltham Creek, Coalinga district, California (Nomland, 1916); lower Sargent of Sargent oil field, Monterey County (Nomland, 1917); lower Fernando of Pico Canyon, near Newhall, Los Angeles County (English, 1914).

Pleistocene: "Rare in upper San Pedro series of San Pedro; three specimens; found also in Pleistocene of Spanish Bight, San Diego, and Barlow's Ranch, Ventura." (Arnold, 1903).

Recent: San Francisco Bay to San Diego, California (Dall, 1921).

This species was described by Gabb from a Recent specimen obtained at Santa Cruz. Later, however, Gabb included in the species fossils from Contra Costa County, supposedly Miocene, but recently shown to be Oligocene by Clark, who believes that they represent a distinct species or variety, *Y. tenuissima* Clark. The specimens obtained from the Pleistocene and Pliocene deposits of California seem to be well within the specific range of variations of the typical Recent form. We have not seen authentic specimens nor figures of *Yoldia cooperi* Gabb, 1865, from the San Pablo or Santa Margarita formations of California (upper Miocene); and Howe, who reports Miocene occurrences, seems to have confused *Y. oregona* Shumard, as figured and redescribed by Dall, with Gabb's species. One of Howe's localities (No. 3321) for *Y. cooperi* Gabb is undescribed in his paper, but is presumably in the "Empire formation." Reagan's report of *Y. cooperi* from Quillayute, Washington (Pliocene of Reagan), probably refers to specimens enclosed in typical Empire Miocene sandstone, but which have been transported by Indians about two miles from their natural occurrence, and, through some misconception, associated by Reagan with the glacial beds in the valley of the Quillayute River.[1] If this interpretation of Reagan's Quillayute record is correct, his figure places *cooperi* in the upper Miocene of Washington. Dall (1922), who reviewed Reagan's identifications, stated that Reagan's *cooperi* was not the Recent form, though closely allied. From a study of Reagan's figure, and available fossil and Recent material, it does not seem possible to identify Reagan's *cooperi* with any other described form. It is most like the Recent *cooperi* but is higher proportionately. A similar large, high form occurs in the Wildcat Beds at Danger Creek (Eel River region), Bridgeville, California. It may be possible that this higher form represents a distinct variety, but until more material is assembled for study it seems best to reserve judgment on its distinctness.

Y. cooperi Gabb differs from *Y. tenuissima* Clark[2] in its more posterior umbones, the rostrum of *cooperi* being considerably shorter. *Yoldia oregona* (Shumard), as figured by Dall, has a relatively longer rostrum than either *tenuissima* or *cooperi*. *Y. carnarosensis* Clark[3], from the San Pablo Miocene of Napa County, California, has a much less attenuated rostrum than *cooperi*. *Y. submontereyensis* and *Y. supramontereyensis* Arnold[4], from the lower and upper Miocene respectively, are quite distinct from *cooperi*.

Y. scissurata Dall has a high posterior dorsal carina on the rostrum and oblique concentric sculpture. It does not belong in this section.

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[1] See Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, no. 212, p. 604, 1913.

[2] Univ. Calif. Publ. Geol., Vol. 11, p. 125, pl. 11, fig. 10, pl. 12, figs. 8, 14, 1918; Vol. 15, p. 78, pl. 8, figs. 5, 9, 1925.

[3] Univ. Calif. Publ. Geol., Vol. 8, p. 446, pl. 48, fig. 6, 1915.

[4] Stewart (Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 62, 1930) considers *tenuissima* a synonym of *supramontereyensis*.

Yoldia oregona (Shumard)

Leda oregona Shumard, Trans. Academy of Science of St. Louis, Vol. 1, pp. 121, 122, no figure, 1858; Gabb, Geol Surv. Calif., Palæo., Vol. 2, p. 121, 1868-9.

Nuculana oregona Shumard, Meek, Checklist Miocene Foss. N. Amer., pp. 5, 27, 1864.

Neilo oregona Shumard, Conrad, Amer. Jour. Conch., Vol. 1, p. 153, 1865.

Yoldia (Cnesterium) oregona Shumard, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 105, pl. 19, fig. 4, 1909; ? Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 310, 1922.

Yoldia oregona Shumard, Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, no. 212, pp. 576, 583, 588, ? 590 (Empire formation, Coos Bay), 1913; Weaver, Proc. Calif. Acad. Sci., Ser. 4, Vol. 6, pp. 37, 51, 1916; ? Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 29 (upper Miocene), 1916.

Type specimen: Probably lost.

Type locality: "Willamette Valley, a few miles south of Oregon City, Oregon Ter.", Shumard.

Oligocene and *Miocene:* Oligocene and probably lower Miocene formations of the northwest; probably not in the upper Miocene (of King County, western Washington, Weaver, 1916, nor the Quillayute, Dall, 1922).

As this is an early described species and the original description is not always readily accessible to students, Shumard's description and remarks are reproduced here in full:

"Shell rather large, ovate, compressed, convex; anterior extremity strongly arched; posterior extremity rostrate, slightly recurved, truncated; basal margin forming a broad curve, slightly contracted near the posterior extremity; ligament margin slightly concave; beaks situated a little in advance of the middle; surface neatly ornamented with regular, concentric, impressed lines, becoming more approximate above; hinge with a line of closely set oblique teeth on each side of the beak. Length, 20 lines; height, 10 lines.

"The specimens in the collection were obtained by Dr. Evans and the writer, in the autumn of 1851, from the Willamette Valley, a few miles south of Oregon City, Oregon Ter. They are all internal casts in fine-grained, soft, yellowish and white argillaceous sandstone of the Miocene epoch. Their surfaces are coated with a thin film of brown hydrated oxide of iron. One of the specimens, a mould of the exterior, shows the surface markings very plainly." (Shumard.)

This species may be the ancestor of *Y. cooperi* Gabb. It appears to belong to the *Kalayoldia* group, although it is an approach to *Cnesterium*. The oblique concentric sulpture of the latter section is of rather sporadic occurrence in several not very closely related species; in fact, it is a tendency which appears in several unrelated species in different groups throughout the family *Nuculanidæ* and thus has very little systematic value. The very strong dorsal keel on the rostrum of *Y. scissurata* Dall, the type of *Cnesterium*, must be considered in conjunction with pronounced oblique sculpture, if the section *Cnesterium* is to have any classificatory value.

Section Cnesterium Dall, 1898.

Cnesterium Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, p. 595, April, 1898, type *Y. scissurata* Dall.

Type (by original destination), *Nucula arctica* Broderip and Sowerby, Zool. Jour., 1829 (not of Gray, Parry's Voyage, Appendix, 1824), = Y. *scissurata* Dall, January, 1897.

Yoldias with a well-developed dorsal keel on the rostrum and pronounced obliquity in concentric sculpture.

As remarked in the discussion under *Y. oregona*, the obliqueness in concentric sculpture cannot be relied upon alone as a character of systematic importance. This section is of very doubtful value, especially as *Y. scissurata* may turn out to be a variety of *Y. limatula*, which lacks the oblique grooves.

Yoldia scissurata Dall

Plate 1, Figure 1

Nucula arctica Broderip and Sowerby, Zool. Jour., Vol. 4, p. 359, pl. 9, fig. 1, 1829, not *Yoldia arctica* Gray, 1824.

? "*Yoldia amygdala* Valenciennes," Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 270, 1888, *fide* Arnold, 1903, p. 100.

Yoldia scissurata Dall, Natural History Society of British Columbia, Bull. 2, Art. 1, p. 8, 1897; Trans. Wagner Inst. Sci., Vol. 3, pt. 4, p. 595, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 99, 100, pl. 17, fig. 13, 1903; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 105, 1909; U. S. Nat. Mus., Bull. 112, p. 13, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 31, pl. 5, fig. 2, 1924.

Yoldia ensifera Dall, Natural History Society of British Columbia, Bull. 2, Art. 1, p. 9, pl. 2, fig. 4, 1897; U. S. Nat. Mus., Bull. 112, p. 13, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 32, pl. 5, fig. 3, pl. 37, fig. 6, 1924.

? *Yoldia ensifera* var. *plena* Dall, Proc. U. S. Nat. Mus., Vol. 34, pp. 256, 257, 1908.

Type specimen: In U. S. National Museum.

Type locality: "St. Paul, Kodiak Island, Alaska"; Recent, *fide* Oldroyd.

Pleistocene: Rare in lower San Pedro series of Deadman Island, Los Angeles County (Arnold).
Recent: Arctic Ocean to Puget Sound (I. S. Oldroyd, 1924); as *ensifera*, to San Diego.

In this species the rostrum is but little produced beyond the regular elongate-ovate shape, the keel on the dorsal margin of the rostrum is well produced and gently curved in profile, the umbones are almost medial and the sculpture is definitely obliquely concentric. It is only varietally distinct from *Y. strigata* Dall, of the Oregonian Tertiary, from which it differs by its less posterior umbones and less abruptly truncated rostrum. The growth lamellæ on the rostrum of *strigata* are curved upward and are vertical for a greater distance than on *scissurata*.

Yoldia ensifera Dall appears to be a lighter colored race of *scissurata* reflecting a slight difference in habitat. The variety *plena* is an individual variation, according to our interpretation of available material. *Y. limatula* (Say)[1] shows no sign of the peculiar oblique sculpture of *Cnesterium*, but it is possible that *scissurata* is only a variety of it. Pacific coast specimens of *limatula* from Puget Sound have a more strongly developed sinus on the anterior ventral portion of the shell than Atlantic specimens. Plate 1, figure 7, is an illustration of a Recent specimen of *Y. limatula* from Puget Sound.

Yoldia scissurata Dall variety strigata Dall

Yoldia (Cnesterium) strigata Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 18, 104, pl. 14, figs. 9, 9*a*, 1909.

Yoldia strigata Dall, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, no. 212, p. 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916; Proc. Calif. Acad. Sci., Ser. 4, Vol. 6, p. 27, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 238, 239, 1916 ("*striagata*"); Howe, Vol. 14, p. 92, and table opposite, 1922.

Type specimen: In U. S. National Museum, No. 153,951.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Empire formation, Coos Bay, Oregon (Dall, 1909; Arnold and Hannibal, 1913; Howe, 1922); "Montesano horizon—*Yoldia strigata* zone" of western Washington (Weaver, 1916).
Pliocene (?): Upper Pliocene of the mouth of Elk River, Oregon (In Stanford Univ. collections, loc. NP. 27).
? *Recent:* ? British Columbia.

The variety *strigata* differs from *scissurata* in the more abruptly truncated rostrum. The growth lines on the rostrum of *strigata* are turned upward (vertical) for a greater distance than on *scissurata*. The Pliocene record is based upon several large specimens in the Stanford collection, some of which have the abruptly upturned growth lamellæ on the rostrum, while others show gently curved lines. This character appears to be variable on different individuals from the same locality. In the Oldroyd Collection at Stanford University there is a Recent specimen from British Columbia which appears to be nearer to *strigata* than to *scissurata*.

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[1] *Nucula limatula* Say, Amer. Conch., Vol. 1, pl. 12, 1831; also figured by Hanley in Sowerby's Thes. Conch., Vol. 3, *Nuculidæ*, p. 139, pl. 1, fig. 9, 1860; type locality Atlantic.

Yoldia keppeliana Sowerby[1] of the Japanese Recent fauna is similar in appearance to *strigata* Dall and probably is closely related.

Genus MALLETIA Desmoulins, 1832

Malletia Desmoulins, Act. Soc. Linn. Bord., Vol. 5, p. 85, Feb. 15, 1832; Gray, Proc. Zool. Soc. London for 1847, p. 190, Nov., 1847; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 321, 1871; Verrill and Bush, Amer. Jour. Sci., Ser. 4, Vol. 3, pp. 56, 57, January, 1897; Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, p. 581, 1898.

Solenella Sowerby, Proc. Zool. Soc. London for 1832, p. 197; Gray, Proc. Zool. Soc. London, p. 190, 1847; Herrmannsen, Indicis Gen. Malac., Vol. 2, pp. 478, 479, 1849; S. P. Woodward, Man. Moll., p. 270, 1853.

Pseudomalletia Fischer, Man. Conchyl., p. 987, 1886, *P. obtusa* Sars and *P. transversa* Ponzi, listed.

Ctenoconcha Gray, *fide* Gray, 1847.

Type: M. chilensis Desmoulins, *fide* Stoliczka, 1871; figured by Fischer, Man. Conchyl., pl. 17, fig. 22, 1886.

Shell oblong or elliptical, blunt posteriorly, not distinctly rostrate; series of teeth unequal; those in the anterior series fewer. (Verrill and Bush.)

This genus is readily distinguished from *Yoldia* by its lack of a distinct rostrum and the absence of lunule and escutcheon. *Tindaria* Bellardi, typified by *T. arata* Bellardi of the Italian Pliocene, also lacks the rostrum, but it has no definite pallial sinus and the teeth occur in a continuous series uninterrupted below the umbones as in *Malletia*.

? Malletia abrupta (Conrad)

Nucula abrupta Conrad, Amer. Jour. Sci., Ser. 2, Vol. 5, p. 423, fig. 3, 1848; reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 150, fig. 3, 1909.

Neilo abrupta Conrad, Amer. Jour. Conch., Vol. 1, p. 153, 1865; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 122, 1868-9.

Malletia abrupta Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 106, 1909.

"Somewhat elliptical, convex; truncated anteriorly; ligament margin rectilinear, oblique; posterior margin obliquely truncated, contracted." (Conrad, original description.)

Type locality: Near Astoria, Oregon; presumably Miocene.

Miocene: Astoria, Oregon (Conrad).

It is uncertain whether this species belongs to *Malletia*. Conrad's figure is of a shell with very prominent umbones. Dall stated that of the Recent Puget Sound species *M. pacifica* Dall most closely resembles Conrad's species, but the Recent shell has less prominent umbones.

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[1] Proc. Malac. Soc. London, Vol. 6, p. 176, text fig. on p. 177, 1904.

Superfamily ARCACEA

Family ARCIDAE

Shell equivalve, or nearly so, trapezoidal, subquadrate, or rounded, with the posterior side equal or longer; ligament exterior, attached to an area beneath and often on both sides of the beak; hinge with taxodont teeth in two similar series meeting below the beaks, the long dimension of the individual comb-like teeth approximately at right angles to the dorsal margin of the valves; pallial line generally distinct, without a sinus; muscle impressions nearly equal.

Geologic range: Cretaceous to Recent.

Distribution: World wide, most abundant in shallow water and in warm and temperate seas.

This family occurs at least as early as the Cretaceous and may have begun in the Jurassic. It is related to the *Cucullæidæ* (including *Parallelodon* Meek and *Cucullæa* Lamarck), which have their lamellar teeth arranged approximately parallel to the dorsal hinge margin.

Genus GLYCYMERIS Da Costa, 1778

Glycymeris Da Costa, Historia Naturalis Testaceorum Britanniæ, p. 168, 1778; Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 4, pp. 572, 607, 1898; Jukes-Browne, Jour. Conchology, Vol. 11, p. 101, 1904; Dall, Proc. Malac. Soc. London, Vol. 10, p. 255, 1912; not *Glycimeris* Lamarck = *Panope* Ménard.

Axinæa Poli, Test. Utr. Sicil., Vol. 1, p. 32, 1791.

Tuceta Bolten, Mus. Boltenianum, p. 172, 1798.

Pectunculus Lamarck, Mém. Soc. Hist. Nat., Paris, Vol. 1, p. 87, 1799; not *Pectunculus* Huddesford, 1770, *fide* Dall, 1912.

Type (by absolute tautonymy), *Arca glycymeris* Linnæus, Syst. Nat., Ed. 10, p. 695, 1758; Ed. 12, p. 1143, 1767; figured by Reeve, Conch. Icon., Vol. 1, *Pectunculus*, pl. 3, figs. 12*a*-*b*, 1843; habitat, coasts of England.

Shell rounded, nearly symmetrical; hinge line curved.

Geologic range: Cretaceous to Recent.

Distribution: World wide, more common in warm and temperate seas.

Da Costa included as a synonym under his *Glycymeris orbicularis* the *Chama glycymeris* of Bellon. This latter species is the *Arca glycymeris* of Linnæus which is thus the type by absolute tautonymy.

Dall has shown that *Pectunculus* Lamarck, 1799, must be supplanted by *Glycymeris* Da Costa, 1778, for the rounded *Arca*-like shells. Da Costa's name is not only prior in date, but *Pectunculus* appears to be preoccupied by Huddesford, 1770.

Glycymeris multicostata (Sowerby)

Pectunculus multicostatus Sowerby, Proc. Zool. Soc. London for 1832, p. 195, 1833; Reeve, Conch. Icon., Vol. 1, *Pectunculus*, pl. 5, fig. 26, 1843; Valenciennes, Voy. Venus, Atlas, Zool., Moll., pl. 20, fig. 2, 1846; Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 71, 1895; Lamy, Jour. Conchyl., Vol. 57 (Ser. 4, Vol. 11), p. 208, 1909.

Glycymeris multicostata Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 254, 1909; U. S. Nat. Mus., Bull. 112, p. 16, 1921; Dall, in Orcutt, West American Scientist, Vol. 19, p. 19, April 27, 1921; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 140, 1927.

Shell of moderate size with numerous rounded radiating ribs and narrow interspaces. Height about 32 mm.; anterior-posterior length about 30 mm.

Pliocene: Santa Anita Point and Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: San Quintin Bay, Lower California, Mexico (Dall, West American Scientist, 1921).

Recent: Lower California, Mexico, to Guayaquil, Peru; questionably from Monterey, California, *fide* Dall, 1921.

In sculpture this handsome species resembles a *Cardium*. It does not appear to occur naturally so far north as California.

Glycymeris septentrionalis (Middendorff)

Plate 1, Figures *21a*, *21b*

Pectunculus septentrionalis Middendorff, Beiträge zu Einer Malacozoologia Rossica, Mém. Sci. Nat. Acad. Imp. St. Pétersbourg, Ser. 6, Vol. 6, Pt. 3, p. 67, pl. 21, figs. 1-3, 1849; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 219, 1857; ? Anderson, Proc. Calif. Acad. Sci., Ser. 3, Geol., Vol. 2, p. 197, 1905.

Glycymeris septentrionalis Middendorff, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 101, pl. 18, fig. 10, 1903; U. S. Geol. Surv., Bull. 396, p. 82, pl. 20, figs. 3, *3a*, January 15, 1910; Bull. 398, p. 125, pl. 42, figs. 3, *3a*, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 418, 1915; Nomland, Vol. 10, table opp. p. 230, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 15, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 41, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 3, 1925; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, no. 16, p. 251, 1929.

Glycimeris septentrionalis Middendorff, Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922.

Miocene: Upper San Pablo formation, upper Miocene, middle California (Clark, 1915).

Pliocene: Etchegoin formation, abundant at several localities in the Coalinga district (Arnold, 1910; Arnold and R. Anderson, 1910; F. M. Anderson, 1905; Nomland, 1917).

Pleistocene: Lower San Pedro formation of Nob Hill, San Pedro (T. S. Oldroyd, 1925); Tomales Bay, Marin County (Dickerson); upper San Pedro series of San Pedro, Signal Hill, Crawfish George's, Deadman Island, and Long Beach, "rare" (Arnold, 1903); near International Boundary Monument No. 251, San Diego County (Frank Stephens, 1929).

Recent: Aleutian Islands to Puget Sound (I. S. Oldroyd.)

This is a rather small, plain looking shell with faint radial ridges and growth striæ. It is probable that the variety *subobsoleta* (Carpenter) should be included as a synonym, but we retain it tentatively until more material can be studied.

According to Howe,[1] the "*Pectunculus septentrionalis* Middendorff" of F. M. Anderson (1905) is *Glycymeris grewingki* Dall.

Glycymeris septentrionalis (Middendorff) variety **subobsoleta** (Carpenter)

? Axinæa barbarensis Conrad, U. S. Pacific R. R. Reports, Vol. 6, p. 71, pl. 3, fig. 11, 1857; Vol. 7, p. 194, pl. 6, fig. 3, 1857.

Axinæa (*? septentrionalis*, Midd. var.) *subobsoleta* Carpenter, Brit. Assoc. Adv. Sci., Rept. for 1863, p. 644, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 425, 1864.

"*Axinæa intermedia* Broderip," Cooper, Seventh Ann. Rept. California State Mineralogist, p. 230, in part, 1888, *fide* Arnold, 1903.

Glycymeris barbarensis Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 100, pl. 18, fig. 9, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; ? Dall, Prof. Paper 59, U. S. Geol. Surv., pp. 108, 109, 1909.

Glycymeris subobsoleta Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 15, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 42, pl. 40, figs. 8, 9, 1924.

Type specimen: In U. S. National Museum.

Type locality: Neah Bay, Washington; Recent.

Pleistocene: Lower San Pedro formation of San Pedro (in Oldroyd collection); "rare in upper San Pedro series of San Pedro, Los Cerritos, Deadman Island and Crawfish George's," all in San Pedro region of Los Angeles County; also Pleistocene of Pacific Beach, San Diego County (Arnold).

Recent: Aleutian Islands to Puget Sound (Dall, 1921), and to Cortez Bank (Oldroyd).

Carpenter considered *subobsoleta* a variety of *septentrionalis*, which seems to be in accordance with the characters of the two forms, the variety being distinguished principally by its more subdued radial sculpture. Dall (1909) believed that Conrad described two distinct species under the name *barbarensis* and that "both appear to be Eocene." The present authors know of no evidence tending to prove these shells to be of Eocene age and they are of the opinion that Dall drew specific lines far too fine in this genus. In a collection of specimens labeled *Glycymeris subobsoleta* (Carpenter) from the Pleistocene of San Pedro there are occasional individuals with a prominent umbo as in Arnold's figure of *barbarensis*. We have, therefore, tentatively considered the "*barbarensis*" of Arnold (1909) synonymous with *subobsoleta* Carpenter; but it is not yet certain whether the shells which Conrad named *barbarensis* are the same as Carpenter's variety. A study of Conrad's type, which according to Dall is in the National Museum, may settle this point.

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[1] Univ. Calif. Publ. Geol., Vol. 14, p. 97, 1922.

As many species of *Glycymeris* are difficult to differentiate, it is probable that not enough allowance has been made for individual variation, for differences in shell characters produced by the direct influence of habitat, and for reduction or obliteration of sculpture by erosion.

Glycymeris kashewarowi (Grewingk)

Pectunculus kashewarowi Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 352, pl. 5, figs. *3a-d*, 1850; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 109, 1909.

Pectunculus kashevaroffi Grewingk, Dall, Seventeenth Ann. Rept., U. S. Geol. Survey, Pt. 1, p. 844, 1896.

Glycimeris kashevarofi Grewingk, Dall, Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 112, 1904 (reissued by Smithsonian Inst., 1910).

Miocene: St. Paul Island, Unga Island and Kadiak Island, off Alaska (Grewingk; Dall, 1896); Peninsula of Alaska, and near Tonki Cape, Igatskoi Bay, Island of Kadiak (Dall, 1904).

This species looks much like *Glycymeris gabbi* Dall, but may have stronger ribs, wider than the interspaces. It has about nineteen distinct growth rings and a hinge with a straight row of fourteen small teeth across the middle, changing abruptly to the curving row of large side teeth, seven to a side. There are several chevron-shaped grooves under the beaks.[1]

Glycymeris grewingki Dall

Glycymeris grewingki Dall, U. S. Geol. Surv., Prof. Paper 59, p. 107, pl. 2, fig. 13, April 2, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, no. 212, p. 590, 1913 (including *G. gabbi* and *G. conradi* Dall as synonyms); Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 97, 1922; Waterfall, Vol. 18, pp. 78, 82, 1929.

Glycymeris conradi Dall, U. S. Geol. Surv., Prof. Paper 59, p. 107, pl. 11, fig. 2, April 2, 1909, not *Axinæa conradi* Whitfield, U. S. Geol. Surv., Monograph 9, p. 230, pl. 29, figs. 10-11, 1885.

Glycymeris gabbi Dall, U. S. Geol. Surv., Prof. Paper 59, p. 108, pl. 11, fig. 5, April 2, 1909.

Glycymeris coalingensis Arnold, U. S. Geol. Surv., Bull. 396, p. 80, pl. 19, fig. 3, January 15, 1910; Bull. 398, pl. 41, fig. 3, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 592, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 418, 1915; Martin, Vol. 9, p. 252, 1916; Nomland, Vol. 10, pp. 220, 300, 1917.

Glycymeris larvata Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 167, 1924, new name for *G. conradi* Dall, not Whitfield.

Type specimens: Of *grewingki*, *conradi*, *gabbi*, and *coalingensis*, in U. S. National Museum.

Type localities: Of *grewingki*, *conradi* and *gabbi*, Miocene of Astoria, Oregon; of *coalingensis*, *Glycymeris* bed on north side of Alcalde Canyon, two miles northeast of Alcalde, Coalinga district, California, Etchegoin formation, Pliocene.

Miocene: Empire formation of Astoria, Oregon (Dall, 1909; Arnold and Hannibal, 1913; Howe, 1922); San Pablo formation of middle California (Clark, 1915); Santa Margarita formation, upper Miocene, north of Coalinga (Nomland, 1917).

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[1] Eichwald, p. 125, 1871, thinks that this species might be a synonym of "*Cardium*" *aleuticum*. He attributes them both to the Cretaceous, probably erroneously. See note, p. 275.

Pliocene: At various localities in the Etchegoin formation of the Coalinga district (Arnold, 1910; Arnold and Anderson, 1910; Nomland, 1917); Merced formation south of San Francisco (Arnold and Hannibal); Etchegoin of Sargent oil field (Martin, 1916); "lower Pico" near Ventura [middle Pliocene] (Waterfall).

This species has been well figured and described under its various names. Weathering can entirely change the appearance of the sculpture, which may account for some of the synonyms noted above.

Glycymeris maculata (Broderip)

Pectunculus maculatus Broderip, Proc. Zool. Soc. London for 1832, p. 126, 1832; Reeve, Conch. Icon., Vol. 1, *Pectunculus,* sp. 4, pl. 1, fig. 4, 1843; Hanley, Cat. Rec. Biv. Shells, p. 164, pl. 19, fig. 34; Mabille, Bull. Soc. Philom., Paris, Ser. 8, Vol. 7, p. 71, 1895; Lamy, Jour. Conchyl., Vol. 57, p. 209, 1909.

Pectunculus giganteus Reeve, Conch. Icon., Vol. 1, *Pectunculus,* sp. 3, pl. 1, figs. 3*a-b*, February, 1843.

Pectunculus (Axinæa) maculatus Broderip, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 147, 1894.

Glycymeris gigantea Reeve, Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 466, 1926; Hanna and Hertlein, Vol. 16, p. 140, 1927.

Pliocene: Coyote Mountain, western Imperial County (Hanna, 1926); Coronados and Carmen Islands, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Santa Rosalia, Gulf side of Lower California, Mexico (collected by Marcel Touwaide); upper Quaternary of San Ignacio Lagoon, west side of Lower California, Mexico (Jordan).

Recent: Gulf of California, Mexico, to Peru (Jordan).

This species attains a large size and has a strong, thick, very convex shell. The umbo protrudes prominently above the dorsal margin of the shell. The radial ribbing is reduced to very low relief or is obsolete, but the surface is finely and evenly radially striated. The hinge plate is heavy, with a curved series of stout chevron-shaped teeth which may be interrupted in the middle by the basal line of the ligamental area.

The slight difference in color pattern between *G. gigantea* Reeve and *G. maculata* Broderip is not believed to be significant by the present authors, hence, the older name has been used. The variations in shape noticed in a series of specimens is partly due to the influence of a rocky habitat. There is a very similar Japanese species.

Glycymeris inæqualis (Sowerby)

Pectunculus inæqualis Sowerby, Proc. Zool. Soc. London for 1832, p. 196, March, 1833; not of Sowerby, Zool. Beechey's Voy., pl. 32, fig. 3, 1839, *fide* Dall, 1909; Reeve, Conch. Icon., Vol. 1, *Pectunculus,* sp. 16, pl. 4, fig. 16, 1843.

Glycymeris inæqualis Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, pp. 155, 254, 1909.

Shell subcordate, solid, heavy, with obtuse radial ridges; lilac gray or white with four or five broad rusty or blackish transverse bands, irregularly disposed; interspaces of the ribs striated; ligament short and a very small part of it behind the umbones. (Dall, 1909.)

Pleistocene: Coast of Oaxaca, Mexico (collected by R. H. Palmer), (Dall, 1909).

Recent: Mazatlan, Mexico, south to Sechura Bay, Peru (Dall).

Glycymeris corteziana Dall

Glycymeris corteziana Dall, Proc. U. S. Nat. Mus., Vol. 52, p. 402, December 27, 1916; Bull. 112, U. S. Nat. Mus., p. 15, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 42, pl. 3, fig. 7, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In U. S. National Museum, Cat. No. 212,431.

Type locality: On edge of Cortez Bank, in 67 fathoms, off California.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Forrester Island, Alaska, to Cortez Bank, California (Dall, 1921).

This is a small species, with a finely concentrically sculptured surface and less conspicuous fine radiating striæ. The beaks are small and the ligamental area very narrow. The type measures 22 mm. in length and 20 mm. in height.

The "*Pectunculus*" *patulus* Conrad, 1849, was considered by Dall to be a poor internal cast of *Lucina acutilineata*, under which we have placed it as a synonym. "*Pectunculus*" *nitens* Conrad[1] was considered by Clark[2] to be a *Limopsis*[3]. It occurs in the Miocene shales at Astoria, Oregon. A number of forms have been named from the earlier Tertiary.

Genus ARCA Linnæus, 1758

Arca Linnæus, Syst. Nat., Ed. 10, p. 693, 1758; Schumacher, Ess. Nouv. Syst. Hab. Vers Test., pp. 171, 172, 1817, type cited *Arca antiquata* Linnæus; Children, Quart. Jour. Sci. Lit. and Arts, p. 319, pl. 6, fig. 65, January, 1823, type cited *A. tortuosa* Linnæus.

Anadara Gray, Proc. Zool. Soc. London for 1847, p. 198, Nov., 1847, type (by original designation), *Arca antiquata* Linnæus.

Scapharca Gray, Proc. Zool. Soc. London for 1847, p. 198, Nov. 1847, type (by original designation), *Arca inæquivalvis* Bruguière, Ency. Méth., Vers, Pt. 1, p. 106, 1789; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 617, 1895.

Anomalocardia (Klein) H. and A. Adams, Genera of Recent Mollusca, Vol. 2, pp. 535, 536, 1858, example *A. antiquata* Linnæus, pl. 124, figs. 5, 5*a*.

Diluvarca Woodring, Carnegie Inst. Publ. No. 366, pp. 40, 41, 1925, type (by original designation) *Arca diluvii* Lamarck.

Type (by subsequent designation, Schumacher, 1817), *Arca antiquata* Linnæus, Syst. Nat., Ed. 10, p. 694, 1758.

Shell subquadrate or trapezoidal, ventricose, ribbed, striated or cancellated; hinge straight, with two series of similar comb-like (taxodont) teeth.

The various natural (and unnatural) groups of Arcas have been well supplied with names, and some confusion has resulted from the lack of agreement concerning the types of the subdivisions. The synonymy and discussion in the present paper has been reduced to the minimum required to make clear what the present authors consider the natural systematic arrangement of the California Pliocene and Pleistocene species.

Subgenus **ARCA**, s. s.

Shell of medium size, inequilateral, heavy, ventricose, without byssal gape; umbones high, stout; sculpture consisting of radial flattened ribs and channeled interspaces, the ribs sometimes multiple or modified by granules or beads; cardinal area generally with chevron-shaped grooves and sometimes horizontal striæ parallel to hinge margin; teeth in two series not separated in the middle.

The typical subgenus was formerly thought to be based upon *Arca noæ* Linnæus, according to the type designation of Gray, 1847. However, nearly a quarter of a century earlier, Children (1823) had designated *Arca tortuosa* Linnæus as genotype, and still earlier Schumacher[4] had definitely designated *Arca antiquata* Linnæus. Schumacher's action makes it possible to retain the name *Arca* in a strict sense for a majority of the Pacific coast species formerly assigned to *Arca* in a broad sense.

Anadara Gray, 1847, is an exact synonym of *Arca, s. s.*, having the same genotype. *Diluvarca* Woodring was based upon a misconception. In 1925 Woodring published figures (pl. 4, figs. 1 and 2) furnished him by the General Secretary of the Linnæan Society of London of Linnæus' type specimen of *Arca antiquata*, and stated that along with Hanley's figure of the exterior (Ipsa Linnæi Conchylia, pp. 93-95, pl. 4, fig. 3, 1855) these photographs "show that *Arca antiquata* externally resembles some of the American species of *Argina*, but has a byssal gape. Its cardinal area is moderately wide, but no ligament grooves are visible. The hinge is heavy; the anterior series of teeth is relatively long and not clearly separated from the posterior series. There are no similar Tertiary or living American *Arcas*."

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[1] Geol. U. S. Explor. Exped. (Wilkes), Vol. 10, p. 726, Atlas, pl. 18, figs. 9*a-b*, 1849.

[2] Univ. Calif. Publ. Geol., Vol. 15, p. 81, 1924.

[3] A. Sassi, Giorn. Ligustico, Vol. 1, Pt. 5, p. 476, 1827.

[4] Ess. Nouv. Syst., p. 172. Schumacher's exact words are: "Pour le type du genre j'ai donné la fig. 2, Pl. xix. de la charnière de l'*Arca antiquata* Lin. qu'on trouve figurée dans Chemn. 7. pag. 201. Tab. 55. fig. 548."

Examination of Woodring's figure of the interior shows that the hinge is not like that of *Argina*, but is like that of "*Diluvarca*." *Arca antiquata* and *Arca diluvii* were similar enough to be confused by many of the early conchologists under the name of the former until they were separated by Lamarck. In the Deshayes and Edwards edition of the Histoire des Animaux sans Vertèbres, Vol. VI, p. 470, 1835, we read that the *diluvii* group always has chevron-shaped grooves on the cardinal area, whereas the true *antiquata* never does. It is added that the true *antiquata* has a thicker shell, less ventricose and broader valves, with more numerous ribs. It is said further that the typical group is the most anciently known and the most common. Linnæus, Chemnitz, and others give the type locality as Jamaica, and a specimen in the Stanford collection from the West Indies agrees with Woodring's figures and with that of Chemnitz (Conch. Cab., Vol. 7, pl. 55, fig. 548) cited by Deshayes as typical, as well as with that of Reeve (Conch. Icon., Vol. 2, species 60, *Arca*). If this is the case, we cannot say "there are no similar Tertiary or living American *Arcas*."

Furthermore, we shall have to refer all, or at least most of the forms classified by Woodring as "*Diluvarca*" to *Arca, s. s.*, for it does not seem practicable to separate groups on the basis of presence or absence of the cardinal grooves. Our common quadrate Arcas agree in thickness of shell and number of ribs better with the typical *antiquata* than with *diluvii*, a good example being our well-known Pacific coast *Arca trilineata* Conrad, some specimens of which are difficult to separate specifically from the type of *Arca, s. s.* This group of forms seems to be so clear as a unit and the different species so closely related that it is hardly desirable to separate them. A separation might seriously obscure important relationships, for it does not seem probable that cardinal grooves are of phylogenetic significance. It is even likely that these grooves exist on the type of *Arca antiquata* but are hidden by the ligament or obscured by erosion. The differences between *Arca antiquata* and *A. diluvii* are, then, specific, not subgeneric or sectional.

It is questionable whether *Scapharca* can be separated or not. *Scapharca* is characterized by a thinner shell and narrower cardinal area, but grades directly into *Arca, s. s.* Dall did not think it desirable to separate the two (that is, *Scapharca* and *Anadara*), and classed them all as *Scapharca* (following the practice of most American paleontologists). Europeans, on the other hand, have preferred the name *Anadara* for the same forms. The Adams brothers separated the two, putting the thicker shelled forms with more obliquely elongated posterior sides into *Anadara*. Since *Anadara* is an exact synonym of *Arca, s. s.*, we have placed *Scapharca* in the synonymy.

It might be well to state here that should Schumacher's type designation of *Arca antiquata* Linnæus for the typical group of Arcas be declared invalid, then Children's designation of *Arca tortuosa* Linnæus would probably have to be used, which would make the group here defined under *Trisidos* Bolten, 1798, the typical subgenus of *Arca*. A restriction of the name *Arca* to the peculiar group *Trisidos*, represented by only one or two species, would obviously be undesirable.[1]

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[1] Stewart (Special Publ. No. 3, Acad. Nat. Sci., Phila., pp. 34, 83, 1930) has since found an intermediate designation of *A. noæ* by Schmidt, 1818.

Arca (Arca) multicostata Sowerby

Arca multicostata Sowerby, Proc. Zool. Soc. London for 1833, p. 21, May 1833; Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 23, pl. 4, fig. 23, 1844; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 134, 1857; Lamy, Jour. Conchyl., Vol. 55, p. 261, 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, pl. 48, fig. 1, 1907; Bull. 309, U. S. Geol. Surv., pp. 107, 152, pl. 38, same figure, 1907; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 45, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Hanna and Hertlein, Vol. 16, p. 146, 1927.

Arca (Scapharca) multicostata Sowerby, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 146, 1894; Dall, Bull. 112, U. S. Nat. Mus., p. 16, 1921.

Arca (Anadara) multicostata Sowerby, Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 71, 1895; Lamy, Jour. Conchyl., Vol. 57, p. 212, 1909.

Pliocene: "Fernando" of Puente Hills, Orange County (Arnold), lower Pliocene; lower Pliocene of 3rd Street tunnel, Los Angeles (Arnold, 1907); Coronados Islands, Lower California, Mexico (Hanna and Hertlein).

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: San Diego, California, to Gulf of California, Mexico (Dall, 1921); Balboa, Los Angeles County, California (A. M. Strong, MS.).

This species has a large, high shell with a somewhat rhomboid outline, moderately elevated umbones, and a large cardinal area. The sculpture consists of numerous prominent, flat-topped radial ribs. The anterior ribs are sometimes slightly granulose, but the typical variety lacks the beaded ribs of variety *camuloensis* Osmont.

Arca (Arca) multicostata Sowerby variety **camuloensis** Osmont

Plate 2, Figures *5a*, *5b*, *5c*

Arca camuloensis Osmont, Univ. Calif. Publ. Geol., Vol. 4, p. 98, pl. 10, figs. 6, *6a*, pl. 11, figs. *6b*, *6c*, 1904; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 543, pl. 47, figs. 1, *1a*, *1b*, 1907; Bull. 309, U. S. Geol. Surv., p. 24, pl. 37, same figures, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 209, 1914; Kew, Bull. 753, U. S. Geol. Surv., p. 78, 1924.

Type specimen: In the University of California collection.

Type locality: Southern California; Pliocene, probably near Camulos.

Pliocene: Near Camulos, Ventura County; Puente Hills, Los Angeles County; foothills of Santa Ana Mountains, Orange County (Osmont); middle Pico of Holser Canyon, Los Angeles County (Arnold; English; Kew; localities S. D. S. N. H. Nos. 217, *217a*, *217b*, coll. by H. R. Gale); middle Pico of locality 228, southeast of Pico Canyon, Los Angeles County (nine specimens, coll. by H. R. Gale).

This large characteristic form has a shell sometimes as much as 8 mm. thick. The beaks are prominent and the cardinal areas high. It is distinguished from the typical *Arca multicostata* Sowerby by the coarser ribs, which are beaded and separated by narrower interspaces. It may be an ecologic variety. Heavy and beaded specimens of *Arca trilineata* Conrad occur with variety *camuloensis*, suggesting that the thickness of both varieties is the result of environmental influences.

Arca (Arca) trilineata Conrad

Plate 2, Figures 1, 4

Arca trilineata Conrad, Proc. Acad. Nat. Sci. Philadelphia, Vol. 8, p. 314, December, 1856; U. S. Pacific R. R. Repts., Vol. 6, Pt. 2, no. 2, p. 70, pl. 2, fig. 9, 1857; Haehl and Arnold, Proc. Amer. Philos. Soc., Vol. 43, p. 24, 1904; Osmont, Univ. Calif. Publ. Geol., Vol. 4, p. 91, pl. 9, figs. 4, *4c*, 1904; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 544, pl. 48, figs. 3, *3a*, 4, 1907; Eldridge and Arnold, Bull. 309, U. S. Geol. Surv., pp. 25, 107, pl. 38, same figures, 1907; Arnold and Anderson, Bull. 322, U. S. Geol. Surv., pp. 47, 58, pl. 24, fig. 5, 1907; Dall, U. S. Geol. Surv., Prof. Paper 59, Appendix, pp. 174, 177, 1909, reprints of Conrad, 1856 and 1857; Arnold, Bull. 396, p. 142, pl. 18, figs. 1, *1a*, Jan. 15, 1910; Arnold and Anderson, Bull. 398, pp. 108, 110, 112, 125, 128, 131, 136, pl. 40, same figures, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 588, 590, 592, 1913; English, Univ. Calif. Publ. Geol., Vol. 8, p. 209, 1914; McLaughlin and Waring, Map folio accompanying Bull. 69, Calif. State Mining Bureau, pl. 1, fig. 45, 1914; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 417, 1915; Martin, Vol. 9, p. 251, 1916; Nomland, Vol. 10, pp. 211, 218, 303, 1917; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, pp. 143-147, 150-152, 154, 156-159, 1919; Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 141, 1922, Howe, Vol. 14, p. 92, 1922; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922; Kew, Bull. 753; U. S. Geol. Surv., p. 78, 1924.

Arca canalis Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 8, p. 314, 1856; U. S. Pacific R. R. Repts., Vol. 6, Pt. 2, no. 2, p. 70, pl. 2, fig. 8, 1857; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 111, also reprints of Conrad's descriptions, in Appendix, pp. 174, 177, 1909; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 251, 1916.

Arca sulcicosta Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pt. 1, p. 31, pl. 9, figs. 53, 53*a*, 1866, pt. 3, p. 124, 1868-9, not Nyst, 1836.

Arca schizotoma Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 659, 1898, new name for *A. sulcicosta* Gabb, 1866, not Nyst, 1836; Arnold, Proc. U. S. Nat. Mus., Vol. 34, pl. 36. fig. 4. 1908; Dall, U. S. Geol. Surv., Prof. Paper, 59, p. 111, 1909.

Arca (Scapharca) trilineata Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 110, pl. 12, figs. 1, 2, 1909.

Shell subtrapezoidal, of moderate size, ventricose, with numerous radial ribs which are subdivided by impressed lines into two or four sub-ribs; umbones rather prominent.

Type locality of both *trilineata* and *canalis:* Santa Barbara, upper Pliocene.

Miocene: Clallam Bay district, Washington (Arnold and Hannibal); Miocene of Coos Bay, Oregon (Dall, 1909; Arnold and Hannibal; etc.); Miocene of Washington (Dall, 1909; Weaver, 1916 "Montesano formation"); San Pablo formation, upper Miocene, of middle California (Clark, 1915; Nomland, 1917); upper Miocene of Washington and southern California (Arnold); etc.

Pliocene: Etchegoin Pliocene of Coalinga region (Arnold; Nomland; Martin; etc.); Etchegoin of Sargent oil field; Purisima formation and Merced formation of Sargent oil field (Martin); Merced formation of San Francisco peninsula (Arnold and Hannibal; and of others); Merced formation of Wilson's Ranch, Sonoma County (Dickerson); lower Fernando of Elsmere Canyon, Los Angeles County (English); Pliocene of San Diego well (Hemphill and Hamlin, *fide* Dall, 1909); and other lower and middle Pliocene localities in California; also in the upper Pliocene at the type locality.

This species is common in the Pliocene deposits of California. *Arca canalis* Conrad appears to be a variant of the typical form unworthy of varietal name. The species, like many Arcas, varies considerably in shape. The typical form is subtrapezoidal, convex, and rather thin or only moderately thick shelled. Another variety which is much less convex does not seem to be worthy of a separate name. On the other hand, it seems strange that the very thick, heavy variety which occurs in the Pliocene of the Santa Clara Valley and the San Diego region has not been named. It is so different from the typical form that it seems desirable to propose for it a new varietal name.

Arca (Arca) trilineata Conrad variety **calcarea,** new variety

Plate 2, Figures 6*a*, 6*b*

Shell like that of typical *Arca trilineata* Conrad, but larger, much thicker, and with more numerous cardinal grooves.

Type specimen: In the Stanford University collection, type No. 436.

Type locality: San Diego well; Pliocene.

Pliocene: Middle Pliocene of the Santa Clara Valley of southern California; middle Pliocene of the San Diego well in Balboa Park, City of San Diego; middle Pliocene at south rim of Mission Valley, and other localities in San Diego region.

This variety appears to be characteristic of the middle Pliocene of the Santa Clara Valley and the San Diego region. It occurs in the Santa Clara Valley region with *Arca multicostata camuloensis* Osmont and may be a reflection of peculiar environmental conditions.

Arca devincta Conrad,[1] an Oligocene or Miocene species of Oregon, appears to be closely related to *Arca trilineata*. It is usually more elongate, with more numerous ribs; and its ribs less frequently show the secondary grooves that give *trilineata* its name. *Arca microdonta* Conrad[2] is as yet not well known, but is said to be a synomyn of *devincta*.[3]

Arca (Arca) perlabiata, new name

Arca labiata Sowerby, Proc. Zool. Soc. London for 1833, p. 21, May, 1833; Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 7, pl. 1, fig. 7, 1843; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 310, 363, 1857; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 101, pl. 18, fig. 4, 1903; not *Arca labiata* D. Solander, Cat. Portland Mus., p. 185, 1786, see Iredale, Proc. Malac. Soc. London, Vol. 12, p. 89, 1916.

Arca (Scapharca) labiata Sowerby, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 117, 1894; Dall, Vol. 37, pp. 155, 253, 1909.

Arca (Anadara) labiata Lamy, Rév. *Arca*, Jour. Conchyl., Vol. 55, p. 274, 1907; Vol. 57, p. 212, 1909.

Shell of medium size and thickness, arcuate below, straight above, with small but prominent prosocoelous beaks; anterior extremity evenly rounded; posterior extremity angular near base, a rather prominent convex angle running from beak to lower portion of the posterior extremity; right valve with twenty-eight square-topped, rather narrow, radial ridges, separated by slightly narrower interspaces; cardinal area triangular, broad, faintly sculptured with parallel lines transverse to hinge line; two nearly equal series of teeth, crowded in middle, becoming slightly oblique and further separated at the distal ends; margins serrate. Dimensions: Long. 28 mm.; alt. 26 mm.; distance between dorsal and ventral margins 20 mm.; umbo to anterior extremity 11 mm.; to posterior extremity 17 mm. (Arnold.)

Pleistocene: Upper San Pedro series of San Pedro, two specimens (Arnold).
Recent: West coast of Lower California, Mexico, to Peru; ? San Diego (Dall, 1909).

Arca (Arca) grandis Broderip and Sowerby

Arca grandis Broderip and Sowerby, Zool. Jour., Vol. 4, p. 365, 1829; Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 4, pl. 1, fig. 4, 1844; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 146, 1927.

Arca (Anadara) grandis Broderip and Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, pp. 154, 253, pl. 25, figs. 9, 10, 1909.

Pliocene: Marquer Bay, Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Magdalena Bay, Lower California, Mexico, south to Peru. "Common in the mud about mangrove roots" (Dall, p. 154).

Arca (Arca) tuberculosa Sowerby

Arca tuberculosa Sowerby, Proc. Zool. Soc. London for 1833, p. 19, May, 1833; Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 18, pl. 3, fig. 18, 1844; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 135, 1857; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Arca (Scapharca) tuberculosa Sowerby, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 146, 1894; Dall, Vol. 37, pp. 154, 253, pl. 27, fig. 4, 1909.

Arca (Anadara) tuberculosa Sowerby, Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 71, 1895; Lamy, Jour. Conchyl., Vol. 55, p. 209, 1907; Vol. 57, pp. 211, 212, 1909.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: "From Cedros Island, west coast of Lower California, in mangrove swamps and muddy places, south to Peru" (Dall, 1909).

Arca (Arca) formosa Sowerby

Arca formosa Sowerby, Proc. Zool. Soc. London for 1833, p. 20; Hanley, Cat. Rec. Biv. Shells, p. 160, pl. 19, fig. 9, 1843.
Arca (Scapharca) formosa Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 253, 1909.

Pleistocene: Upper Pleistocene, west coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Lower California, Mexico, to Paita, Peru (Dall, 1909).

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[1] Geol. U. S. Expl. Exped., Vol. 10, p. 726, Atlas, pl. 18, fig. 10, 1849; type specimen No. 3499 U. S. National Museum.

[2] Appen. Prelim. Rept. W. P. Blake, U. S. House of Representatives, Doc. 129, p. 13, July 1855; U. S. Pacific R. R. Repts., Vol. 5, p. 323, pl. 3, fig. 29, 1857; type specimen No. 1844 U. S. National Museum.

[3] See Bull. 53, U. S. Nat. Mus., pp. 55, 56, 1905.

Subgenus **NAVICULA** Blainville, 1818

Navicula Blainville, Dict. Sci. Nat., Vol. 10, p. 216, table, 1818, *fide* Herrmannsen, Indicis Generum Malacozoorum, Vol. 2, p. 109, 1847; Cox, Rept. Paleo. Zanzibar Protectorate, p. 93, 1927; not *Navicula* Spix, 1827, a gastropod.

Byssoarca Swainson, Proc. Zool. Soc. London for 1833, p. 16, 1833; Zool. Illustr., Ser. 2, Vol. 3, pt. 26, pl. 118, 1833; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 149, 1846.

Arca, sensu stricto, of Dall; of Woodring, 1925; and of several other authors.

Type (*fide* Herrmannsen, 1847, and Cox, 1927), *Arca noæ* Linnæus; Mediterranean Sea; Recent; figured by Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 72, pl. 11, fig. 72, 1844.

Hinge line long, with numerous, very small teeth which are quite or nearly vertical and equal in size but may increase in length and obliquity toward the ends of the hinge line, separated or nearly separated by a slight gap usually directly under the beak; beaks anterior, hence the anterior series of teeth shorter than the posterior series; beaks high, separated by wide, obliquely triangular areas which are marked by several chevron-shaped grooves and by fine vertical and horizontal striations; shape of shell modified by a prominent, somewhat angulated fold running from the beaks to the posterior ventral corner; toward the hinge line from this fold a shallow depression giving the posterior end of the hinge a keel-like aspect; directly back of the beak a more or less conspicuous broad sinus ending in a byssal gape; the anterior ventral corner and back slope more evenly rounded; the whole surface (except the cardinal area) sculptured by somewhat irregular, coarse and fine radial striations or riblets and less pronounced growth lamellæ.

This subgenus has generally been considered the typical group of *Arca* because of an apparently erroneous conception of the type. It seems to be chiefly a warm-water group.

Arca (Navicula) terminumbonis, new species

Plate 1, Figures 18*a-c* (Type); Figures 19*a-c*, 20*a-c*, 22 (Paratypes)

Shell of medium size and thickness, elongately trigonal; beaks near or at the extreme anterior end of the shell where the straight hinge line makes an acute angle with the area along the ventral margin; teeth divided near the middle by a slight internal thinning of the shell wall, outer teeth of the posterior series becoming rapidly elongated and very oblique, almost horizontal at the end of the hinge, continuing a short distance around the corner, teeth of the anterior series showing the same tendency but to a much less degree; cardinal area high, long, sculptured by many oblique grooves; beaks twisted forward but not sharply overhanging as in *Arca noæ*; from the beaks an oblique fold running out to the posterior ventral corner, dividing into two broad branches as it goes, separated from the cardinal area by a depression; shell near the ventral margin of the valve nearly perpendicular to the plane of the valve margins; ventral margin arched around a very large byssal gape; sculpture consisting of many fine wavy radial striations and a few concentric ripples.

Dimensions: Greatest dimension (measured along the ventral margin), 75 mm.; greatest dimension measured perpendicular to the plane of the ventral area, 32 mm.; depth, 22 mm.; length of hinge line, 56 mm.

Type specimen: San Diego Society of Natural History, No. 79, collected from S. D. S. N. H. Loc. 207, basal Pliocene of Elsmere Canyon, Los Angeles County, California, by H. R. Gale.

Pliocene: Basal Pico of Locality 207, Elsmere Canyon, Los Angeles Co., the type and two paratypes; locality 202, Elsmere Canyon, one paratype (coll. by H. R. G.).

It was at first believed that two species were represented in the specimens listed above, but it is probable that some of the differences in shape are due to a rocky habitat. The smallest specimen (pl. 1, figs. 20*a-c*) is very different in shape from the type specimen (figs. 18*a-b*), and suggests a relationship with *Arca pacifica*.

While *Arca terminumbonis* appears to be more closely related to *Navicula* (group of *Arca noæ*) than to other subgenera, it could readily be placed in a separate section from the typical. *Arca merriami* (Van Winkle) from the Oligocene of Washington and middle

California has the shape of *Navicula* and may be related; but it seems to be, in hinge characters, somewhat more like a *Barbatia*. It may be a connecting link or may be related to *Obliquarca* Sacco.

Arca (Navicula) pacifica (Sowerby)

Byssoarca pacifica Sowerby, Proc. Zool. Soc. London for 1833, p. 17, 1833; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 138, 1857.

Arca pacifica Sowerby, Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 75, pl. 11, fig. 75, 1844; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 146, 1894; Lamy, Jour. Conchyl., Vol. 55, p. 19, 1907; Vol. 57, p. 209, 1909; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 251, 1909; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 152, 153, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 144, 1927.

Pliocene: Half mile back from the shore at Santa Antonita Point, Lower California, Mexico (Hanna and Hertlein).

Pleistocene: Upper Quaternary of Scammons Lagoon, west coast of Lower California, Mexico (Jordan); upper Pleistocene, coast of Oaxaca, Mexico (collected by R. H. Palmer).

Recent: Scammons Lagoon, Lower California, Mexico, to Tumbes, Peru (Jordan).

This species has a much deeper and more coarsely sculptured shell than *A. terminumbonis*, new species. Reeve has a good figure of it.

Subgenus **BARBATIA** Gray, 1847

Barbatia Gray, Synopsis of the Contents of the British Museum, Ed. 42, p. 151, 1840, *nomen nudum;* Proc. Zool. Soc. London for 1847, p. 197, 1847; H. and A. Adams, Gen. Rec. Shells, Vol. 2, p. 534, pl. 124, figs. 4, 4*a*-*b*, 1857; Dall, Trans. Wagner Inst., Vol. 3, p. 614, 1898; Woodring, Carnegie Inst. Publ. No. 366, p. 33, 1925; Gardner, U. S. Geol. Surv., Prof. Paper 142A, p. 25, 1926.

Type (by original designation, Gray, 1847), *Arca barbata* Linnæus, Mediterranean; Recent; figured by Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 83, pl. 13, fig. 83, 1844.

According to Gray, *Barbatia* is distinguished by the lengthening and the increasing obliquity of the teeth from the center to the ends of the hinge line, and by the hairy (bearded) epidermis. It is usually a comparatively small, not very thick shell with somewhat irregular fine radial striations and a narrow cardinal area. It is elongate-quadrangular in outline, with the corners well rounded, and usually has only a narrow byssal gape.

Arca (Barbatia) reeviana d'Orbigny

"*Arca helblingii* Bruguière," Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 90, pl. 14, fig. 90, 1844, not *Arca helblingii* Bruguière, Ency. Méth. Vers, Vol. 1, p. 99, 1789, *fide* Dall, 1909.

Arca reeviana d'Orbigny, Voy. Amer. Mérid., p. 635, 1846, *fide* Dall, 1909; in Ramon de la Sagra, Hist. Cuba, Moll., Vol. 2, p. 320, 1853, *fide* Lamy, 1909; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 278, 1857.

Byssoarca reeviana d'Orbigny, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 147, 1894.

Arca (*Barbatia*) *reeviana* Orbigny, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 252, 1909.

Arca reeviana Orbigny, Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 140, 1927.

Pliocene: Carmen Island, Lower California, Mexico, coll. by Dr. Fred Baker (Hanna and Hertlein).

Recent: Lower California, Mexico, to Peru and Galapagos.

There have been reports of finding this species at Balboa, Los Angeles County, California.

Arca (Barbatia) reticulata Gmelin

Arca reticulata Gmelin, Syst. Nat., Ed. 13, Vol. 1, p. 3311, 1790; Chemnitz, Conch. Cab., Vol. 7, p. 193, pl. 54, fig. 540, 1784.

? *Arca plicata* Chemnitz, Conch. Cab., Vol. 11, p. 244, pl. 204, fig. 2008, 1795.

Arca gradata Broderip and Sowerby, Zool. Journal, Vol. 4, p. 365, 1829; Gray, Zool. Beechey's Voy., Moll., p. 152, pl. 43, fig. 1, 1830; Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 92, pl. 14, fig. 92, 1844; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 252, 1909; Woodring, Carnegie Inst. Publ. No. 366, pp. 36, 37, 1925.

? Byssoarca divaricata Sowerby, Proc. Zool. Soc. London for 1833, p. 18, 1833; Reeve, Conch. Icon., Vol. 2, *Arca*, sp. 108, pl. 16, fig. 108, 1844.
Byssoarca gradata Broderip and Sowerby, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 141, 1857; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 147, 1894.
Barbatia (Acar) reticulata Gmelin, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 629, 1898.
Arca (Acar) plicata Chemnitz, Lamy, Jour. Conchyl., Vol. 55, p. 81, 1907; Vol. 57, pp. 210, 211, 1909.
Barbatia reticulata Gmelin, Dall, Bull. 112, U. S. Nat. Mus., p. 16, 1921.
Arca (Barbatia) reticulata Gmelin, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 45, 1924.

Pleistocene: Upper Pleistocene, coast of Oaxaca, Mexico (collected by R. H. Palmer).
Recent: San Pedro, California, to Ecuador (Oldroyd); Monterey ? (Berry); also Caribbean.

Chemnitz (1784) stated that he could not give the habitat of *A. reticulata*, but that he believed it came from the West Indies. According to Woodring (1925) Kobelt[1] stated that the shell figured by Chemnitz as *Arca reticulata* came from the Indian Ocean. This might be an error on the part of Kobelt. Woodring points out that "the figure does not resemble the West Indian *Arca* that goes under the name of *reticulata*." Dall, in his Wagner Institute Memoir on the Florida Tertiary (p. 629, 1898), considered *reticulata* and *gradata* con-specific, the latter having been described from Mazatlan, west coast of Mexico. Dall likewise considered *A. divaricata* Sowerby, 1833, as an additional synonym, although *divaricata* supposedly came from the East Indies. Under the circumstances we have tentatively considered *A. reticulata* Gmelin and *A. gradata* Broderip and Sowerby synonymous, perhaps representing a single species occurring on both Atlantic and Pacific coasts of America.

Woodring (1925) designated *A. gradata* as type of *Acar* Gray,[2] a minor subdivision of *Barbatia* with reticulate sculpture.

Subgenus **TRISIDOS** Bolten, 1798

Trisidos Bolten, Mus. Bolt., p. 175, 1898, only species *Arca tortuosa* Linnæus.

This is *Trisis* Oken, 1815, and *Parallelepipedum* (Klein) H. and A. Adams, Dec., 1857, both of which have the same type. It is a peculiarly twisted *Arca* with a long hinge line and much reduced cardinal area, now living in India and China.

Children (1823) cited *A. tortuosa* as the type of *Arca*. Hence, if Schumacher's prior type designation is disregarded, this peculiar group might become typical *Arca*.[3]

Superfamily Pteriacea

Family PINNIDAE

Shell mytiliform, not alate, with two adductor muscles, the anterior smaller; valves equal, truncate, and wholly open behind; hinge without teeth; cardinal area linear; ligament internal; byssus present; shell structure coarsely prismatic, the inner layer thinner and nacreous.

The family dates from the Paleozoic, *Palæopinna* Hall of the Devonian and *Aviculopinna* Meek of the Carboniferous and Permian being the early representatives of the group. The shell of the *Pinnidæ* is made up partly of very coarse prisms like *Inoceramus*, the inner pearly layer readily splitting away when dessicated.

Genus PINNA Linnæus, 1758

Pinna Linnæus, Syst. Nat., Ed. 10, p. 707, 1758, list includes *P. muricata*, *P. rudis*, and others; Children, Quart. Jour. Sci. Lit. Arts, Vol. 15, p. 34, pl. 1, fig. 80, April, 1823, type *Pinna rudis* Linnæus; Gray, Proc. Zool. Soc. London for 1847, p. 199, 1847, type *Pinna rudis* Linnæus.

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[1] Syst. Conch. Cab. Martini und Chemnitz, Band 8, Abtheilung 2, *Arca*, p. 211, 1891.

[2] Ann. Mag. Nat. Hist., Ser. 2, Vol. 19, p. 369, 1857.

[3] Schmidt's designation is somewhat questionable. See note on *Arca*.

Type (by absolute tautonymy), *Concha pinna* Hasselquist = *Pinna muricata* Linnæus, 1758; habitat, East Indies (see discussion below).

Shell equivalve, wedge-shaped, with umbones at extreme end, which is acute; posterior (ventral) side truncated and gaping; ligamental groove long, linear; anterior adductor scar apical, posterior scar subcentral, large and ill-defined; pedal scar in front of posterior adductor.

Children (1823) and Gray (1847) both cited *Pinna rudis* L. as type, but Linnæus (1758) gave "*Concha Pinna*" Hasselquist as a synonym of *Pinna muricata* and according to the International Rules of Zoological Nomenclature[1] *muricata* becomes the type by absolute tautonymy. It appears that Linnæus wrote the names for Hasselquist (1757), so the "*Pinna*" of *Concha Pinna* was properly used as a specific name.

There has been doubt about the recognition of *Pinna muricata* Linnæus. Reeve[2] figures what, "according to Chemnitz and Lamarck, appears to be the Linnæan *P. muricata*," but gives the habitat as West Indies. Chemnitz,[3] who studied the species critically, attributes it to the "Ostindischen Meeren" and Reeve seems to have translated this as West instead of East Indies. Rumphius, according to von Born[4], reported it from Amboyna, which is in the Moluccas, and although Lister attributed it to the Mediterranean, we believe the latter to be an error. There are several named forms of *Pinna* in the Indo-Pacific region which fit the original description of *muricata* and likewise the figures of Chemnitz and Reeve. One of these should be selected by the first reviser as the Linnæan *muricata*. Dall[5] has expressed the opinion that the true *muricata* is an Oriental species, but he does not attempt to settle the difficulty. However, the uncertainty does not disturb the present conception of the genus, for all of the species of which the Linnæan *muricata* is one, appear to belong to the same group as *P. rudis*.

Subgenus **PINNA**, s. s.

Shell elongate, with a longitudinal crack or sulcus filled with cartilage in the middle of each valve.

The Atrinas are generally shorter and broader than the true Pinnas and lack the longitudinal medial sulcus which sometimes tends to give fossil Pinnas a subangular cross-section.

Pinna (Pinna) latrania Hanna

Pinna latrania G. D. Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 475, pl. 27, fig. 1, text fig. 1, March 23, 1926.

Shell thin, long and slender, apical angle acute (27°); surface apparently unmarked externally by ridges, ribs, or spines, except for a heavy longitudinal mid-rib in each valve, the mid-rib being rounded, convex internally, apparently sharply carinate externally, and divided longitudinally, the two parts being united by cartilage; the length of this rib unobtainable from available material, but in other species it does not extend entirely to the beak; each valve deeply sulcate at the mid-rib so that in looking down upon it, it is double-looped. Length of type specimen, 135 mm.; width from hinge line down, 63 mm.; gape posteriorly, 51 mm.; length of hinge line, 116 mm.; length of byssal scar, 85 mm. (Hanna.)

Type specimen: In U. S. National Museum, No. 324,593. Plaster cast in California Academy of Sciences.

Type locality: Coyote Mountain, Imperial County, California; Pliocene.

Pliocene: At the head of Garnet Canyon on the north side of Coyote Mountain, Imperial County, California (Hanna).

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[1] See Article 30d, and Opinion 16. The Rules and Summaries of Opinions were republished in Proc. Biol. Soc. Wash., Vol. 39, pp. 75-103, July 30, 1926.

[2] Conchologia Iconica, Vol. 11, *Pinna*, pl. 13, fig. 23, May, 1858.

[3] Neues Systematisches Conchylien Cabinet, Vol. 8, pp. 235-236, 1785.

[4] Testacea Musei Caesarei Vindobonensis, p. 133, 1780.

[5] Trans. Wagner Inst. Sci., Vol. 3, p. 661, 1898.

Pinna (Pinna) mendenhalli Hanna

Pinna mendenhalli Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 476, pl. 27, fig. 2, March 23, 1926.

Type specimen: In U. S. National Museum, No. 324,593, the same number as for the preceding species.

Type locality: Coyote Mountain, Imperial County; Pliocene.

Pliocene: At the head of Garnet Canyon, on the north side of Coyote Mountain, Imperial County, California (Hanna).

This is a thick and heavy species with an apical angle of 47°. It has the mid-rib, which places it in the subgenus *Pinna.*

Subgenus **ATRINA** Gray, 1840

Atrina Gray, Synops. Cont. Brit. Mus., Ed. 42, p. 151, 1840; Ed. 44, p. 83 1842, *fide* Iredale, Proc. Malac. Soc. London, Vol. 10, p. 303, 1913; Gray, Proc. Zool. Soc. London, 1847, p. 199, 1847.

Type (by subsequent designation, Gray, 1847), *Pinna nigra* Chemnitz, Indo-Pacific; Recent.

Shell shorter than that of *Pinna, s. s.*, and without the longitudinal medial sulcus.

Pinna (Atrina) alamadensis Yates

Pinna alamadensis Yates, in Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 259, footnote, 1888.
Pinna alamedensis Yates, Cooper, Calif. St. Mining Bureau, Bull. 4, pt. 5, p. 56, pl. 4, fig. 53, 1894; Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 420, 446, 447, pl. 48, fig. 3, 1915; Nomland, Vol. 10, pp. 301, 302, 308, 1917.
Pinna (Atrina) alamedensis Yates, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 665, 1898.
? Pinna venturensis Yates, in Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 259, footnote, 1888; Cooper, Calif. St. Mining Bureau, Bull. 4, pt. 5, p. 56, pl. 4, fig. 54, 1894.
? Pinna (Atrina) venturensis Yates, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 665, 1898.

This species has nine concentric, inequidistant, rounded wrinkles emanating from the open side, and turning toward the hinge nearly at right angles, the entire shell marked by small longitudinal narrow ribs (about forty), which, radiating from the apex, extend to the basal margin, becoming more indistinct as they approach the lower margin. These ribs at their intersections with the lines of growth are ornamented by slight elevations forming zigzag markings along the lines of growth. The hinge is straight the entire length, the opposite side running parallel for about half the distance from base to apex, where it makes a sharp curve, and continues at an angle of about forty-five degrees to the apex. Length nine, width five, and thickness about two inches. (Yates.)

Type localities: Of *alamadensis*, Alameda Creek, Alameda County, Miocene; of *venturensis*, Casitas Pass, Ventura County, Miocene.

Miocene: Vaqueros, lower Miocene, at Casitas Pass; Monterey-Temblor, middle Miocene (Nomland); upper San Pablo, upper Miocene (Clark).

Pinna venturensis Yates may be conspecific. Clark (1915) reported *alamadensis* as very common in the San Pablo Miocene, where it attains a length of ten inches and a maximum width of about five and a half inches.

Pinna (Atrina) bicuneata Nomland

Pinna bicuneata Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 301 (list), 308, pl. 15, figs. 1*a-b*, November 8, 1917.

Shell elongate-cuneate; in cross-section thin, acutely elliptical. Hinge line long, nearly straight; ventral margin slightly concave near beaks; posterior end evenly rounded. Sculptured by approximately ten distinct radiating ridges which appear to be absent on lower one-third of shell. Length, 96 mm.; width, 44 mm.; thickness, 18 mm.; umbonal angle, 35 degrees. (Nomland.)

Type specimen: University of California, No. 11,307.

Type locality: Ten miles northeast of Coalinga, upper Miocene.

Miocene: Santa Margarita formation, near Coalinga; upper San Pablo formation, Las Trampas Ridge, Concord Quadrangle, Contra Costa County (Nomland).

? *Pliocene:* Near Standard Oil Company, Powell well, eight miles northeast of Bradley, Monterey County, possibly lower Etchegoin ? (Nomland).

There are several other Pinnas in the earlier Tertiary. In the California Recent fauna there is but one known species, *Pinna* (*Atrina*) *oldroydi* Dall[1]. Mr. Frank Stephens, of San Diego, reports a *Pinna* in the Pleistocene deposits along the coast of San Diego County, but the specimens have not yet been studied.

Family PTERIIDAE

Shell oblique, Aviculoid, alate, inequivalve, adult with one adductor scar; ligament alivincular; byssus present; young with hinge teeth, becoming obscure with age.

This family dates from the middle Paleozoic and includes such well-known extinct genera as *Pseudomonotis* Beyrich (Devonian to Cretaceous), *Monotis* and *Halobia* Bronn, and *Daonella* Mojsisovics (Triassic). It is somewhat intermediate between the dimyarians and the monomyarians, the young possessing two adductor muscles, the anter or becoming very small or absent in the adult.

Genus PTERIA Scopoli, 1777

Pteria Scopoli, Introd. Hist. natur. p. 397, 1777, sole species *Mytilus hirundo* Linnæus; Meek, U. S. Geol. Surv. Territories, Vol. 9, pp. 28, 29, 1876; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 668, 1898.

Avicula Bruguière, Enc. méth. Vers, Vol. 1, fasc. 2, p. 536, 1792; Children, Quart. Jour. Sci., Lit., Arts, p. 37, 1823, type cited *Avicula crocea* Lamarck.

Type (by monotypy), *Mytilus hirundo* Linnæus, figured by Bucquoy, Dautzenberg and Dollfus, Moll. Mar. Roussillon, Vol. 2, fasc. 4, pl. 22, 1890, Mediterranean; Recent.

Shell oblique, inequivalve, eared, byssal notch present under anterior ear of right valve; cardinal area linear, with obscure or obsolete teeth; dorsal margin long, straight; sculpture not prominent; shell fragile.

Subgenus **PINCTADA** Bolten, 1798

Margaritifera P. Browne, Civil and Natural History of Jamaica, second edition, p. 412, 1789; Harris, Cat. Tert. Moll. Brit. Museum, Pt. 1, p. 325, 1897; Jameson, Proc. Zool. Soc. London for 1901, Vol. 1, p. 372, 1901.

Pinctada Bolten, Mus. Boltenianum, p. 166, 1798, first species, *P. margaritifera;* Iredale, Proc. Malac. Soc. London, Vol. 11, p. 305, 1915.

Unionium Link, Beschr. Rost. Samml., Abth. 3, p. 155, 1807, *fide* Harris.

Margaritiphora Megerle, Mag. Gesellschaft Naturforschender Freunde, Berlin, Jahrgang 5, p. 66, 1811; type *M. communis* = *M. margaritifera* Linnæus, *fide* Jameson; "*Margaritophora*" of L. Agassiz, Nomen. Zool., Index Univ., 1846, *emend. pro. Margaritiphora* Megerle.

Margarita Leach, Zool. Misc., Vol. 1, p. 107, 1814, type *M. sinensis* Leach = *M. margaritifera* Linnæus, China; not *Margarita* Leach, 1819.

Perlamater Schumacher, Ess. Nouv. Syst. Hab. Vers, Test., p. 107, 1817.

Meleagrina Lamarck, Anim. s. Vert., Vol. 6, p. 150, 1819; not Lamarck, 1812, vernacular use.

Type (by subsequent designation, Iredale, 1915), *P. margaritifera* (Linnæus), Oriental seas.

Shell less oblique than in *Pteria, s. s.*, valves flatter and nearly equal; posterior ears or hinge continuation smaller or entirely absent; pedal impression blended with that of the adductor; shell pearly within.

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[1] Nautilus, Vol. 14, p. 143, 1901; figured in Bull. 112, U. S. Nat. Mus., pl. 2, figs. 4, 5, 6, 1921, and by Oldroyd, Stanford Univ. Publ. Geol. Vol. 1, pl. 28, fig. 12, 1924. Range San Pedro Bay to San Onofre, southern California.

The pearl-oysters have long been known under the name of *Margaritifera*. This name was proposed by Patrick Browne in the "Civil and Natural History of Jamaica," the first edition of which was pre-Linnæan (1756), and the second has been declared nomenclatorially invalid under suspension of the rules by Opinion 89 of the International Commission on Zoological Nomenclature. *Margaritifera* of Humphrey in the Museum Calonnianum (p. 44, 1797) is likewise invalid. *Pinctada* Bolten is the earliest name that can be used for the group, and should the Museum Boltenianum be rejected, *Unionium* Link, 1807, is next in order. There are at least three other names available earlier in date than Lamarck's *Meleagrina*, which was first published as a generic name in 1819, his use of it in 1812 being in the vernacular.

The pearl-oysters have been of commercial importance on the west Mexican coast and in the Panamic region for many years. In addition to the single species listed below, *Pteria (Pinctada) fimbriata* Dunker (1852, not Reeve, 1857) occurs in the Gulf of California. The *Pteria vivesi* de Rochebrune, 1895, is a *Pteria, s. s.*, and a synonym of *P. peruviana* Reeve in the Iconica, 1857.

Pteria (Pinctada) mazatlanica (Hanley)

Margaritiphara mazatlanica Hanley, Cat. Rec. Biv. Shells, p. 388, pl. 24, fig. 40, 1855.

Avicula barbata Reeve, Conch. Icon., Vol. 10, *Avicula*, pl. 5, fig. 9, 1857.

Meleagrina mazatlanica Hanley, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 564, 576, 1864.

Meleagrina margaritifera Linnæus, Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 72, 1895.

Pteria (Margaritifera) margaritifera L. var. *mazatlanica* Hanley, Jameson, Proc. Zool. Soc. London for 1901, Vol. 1, pp. 376, 377, 1901; Lamy, Jour. Conchyl., Vol. 57, p. 227, 1909.

Margaritifera mazatlanica Hanley, Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, pp. 141, 146, 150, 1927.

Pliocene: Southwest point of Coronados Island; also on Ceralbo Island, Gulf of California, Mexico (Hanna and Hertlein).

Recent: Gulf of California to Panama.

Jameson, whose excellent paper, "Mother-of-Pearl Oysters," is referred to above, considered *P. mazatlanica* an unusually convex and aberrant variety of *P. margaritifera* Linnæus, the typical form of which appears to belong to the warm western Pacific. The posterior angle of *mazatlanica* is acute or rarely a right angle; the anterior margin below the byssal notch "projects further forward than in any other variety, so that a perpendicular to the hinge from its anterior end would cut off about ⅓ of the valve."[1] Recent specimens are of a grayish yellow or light brown color; the radial rows of spots are very indistinct, and approximate the ground color of the shell. The inner surface of the valve has a yellowish brown lip, the nacreous portion being of a silvery white with a golden or brassy margin.

? Family PHILOBRYIDAE

Genus PHILOBRYA Carpenter, 1872

Bryophila Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 314, April, 1864; Tryon, Struct. Syst. Conch., Vol. 3, p. 284, 1884; not *Bryophila* Trietschke, in Ochsenheimer, Die Schmetterlinge von Europa, Vol. 5, p. 57, 1825, Lepidoptera.

Philobrya Carpenter, Smithsonian Miscellaneous Collections, Publication No. 252, Index, p. 21, substitute name for *Bryophila*.

Type (by monotypy), *Bryophila setosa* Carpenter.

Shell like that of a minute *Pinna* with pointed beaks; upper margin straight, with a strong internal ligament, anteriorly somewhat indented by the byssal sinus, ventrally and posteriorly rounded and gaping; posterior muscular scar subcentral, indistinct. (Tryon.)

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[1] Jameson, *loc. cit.*

The generic name *Bryophila* having been preoccupied, Carpenter proposed in the index to the Smithsonian Reprint of his "Supplementary Report" the name *Philobrya* as a substitute. The single species appears to be closely related to the *Pinnidæ*, the shape and shell structure being like that of *Pinna*.

Philobrya setosa (Carpenter)

Bryophila setosa Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 314, April, 1864; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 538, 612, 618, 645, 1864; Bernard, Journ. de Conchyl., Vol. 45, p. 10, text figures 1, 4, pl. 1, fig. 1, 1897.

Philobrya setosa Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 17, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 48, pl. 54, figs. 32 to 35, 1924.

Type specimen: In U. S. National Museum.

Type locality: Cape San Lucas, Lower California; Recent.

Pleistocene: San Pedro cut, Los Angeles County (T. S. Oldroyd collection).
Recent: Forrester Island, Alaska, to Gulf of California, Mexico (Dall).

Superfamily OSTRACEA

Shell sessile, inequivalve, often irregular, sometimes very heavy, not auriculate, without gape; composed of subnacreous or porcellanous and prismatic shell layers; hinge edentulous or with degenerate schizodont teeth.

Geologic range: Carboniferous to Recent.

Family OSTREIDAE

Shell distorted by sessile habit; only the posterior adductor muscle present in the adult; generally attached by the left valve, which may be more ventricose than the right.

Genus OSTREA Linnæus, 1758

Ostrea Linnæus, Syst. Nat. Ed. 10 p. 696 1758; Müller Prodr. Zool. Danica pp. xxxi and 247. 1776; Children, Quart. Jour. Sci., Lit., Arts, Vol. 15, p. 44, pl. 2, fig. 94, April, 1823; Meek, U. S. Geol. Surv. Territories, Vol. 9, p. 10, 1876.

Type (by subsequent designation, Children, 1823), *Ostrea edulis* Linnæus, figured by Reeve.

Shell irregular, with terminal beaks; sculptured by imbricating lamellæ and plications, or rarely almost smooth; lower valve generally deeper than upper valve, which may be flat or externally concave; ligament in a mesial groove.

In view of a forthcoming report on the Pacific coast Neocene subgenera and species of *Ostrea*, the treatment of the group here will consist of a mere chronological listing of the Pliocene and Pleistocene species.

Ostrea californica Marcou

Ostrea virginica var. *californica* Marcou, Geology of North America, p. 32, pl. 5, figs. 2, 2*a*, Zurich, 1858; Hanna and Hertlein, Nautilus, Vol. 41, p. 46, Oct. 1927.

"*Ostrea iridescens* Gray," Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 468, pl. 26, figs. 4-7, 1926; not of Gray, MS., Hanley, Conch. Misc., *Ostrea*, pl. 2, figs. 6, 7, 1854.

Pliocene: Coyote Mountain, Imperial County (Hanna, 1926).

Hanna and Hertlein (1927) state that the Coyote Mountain form referred by Hanna (1926) to *O. iridescens* Gray is exactly like Marcou's figures of *californica*. The Recent west Mexican *Ostrea* which Carpenter, Dall, and others have referred to "*Ostrea iridescens*

Gray" appears to be a synonym of *Ostrea prismatica* Gray[1]. In spite of Dall's remarks (Nautilus, Vol. 28, p. 1, 1914), the present authors believe the name *iridescens* should be dropped in favor of *prismatica* Gray, 1825, for the Gulf of California Recent species. Dall's discussions of oysters have never been satisfactory.

Ostrea megodon Hanley

Ostrea megodon Hanley, Proc. Zool. Soc. of London for 1845, p. 106, 1846; Sowerby, in Reeve's Conch. Icon., Vol. 18, *Ostrea*, sp. 24, pl. 12, figs. 24*a-b*, 1871; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 685, 1898; Nautilus, Vol. 28, p. 1, 1914; Dall, in Orcutt, West American Scientist, Vol. 19, p. 23, 1921; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Jordan and Hertlein, Vol. 15, pp. 427, 428, pl. 28, fig. 1, 1926; Hanna and Hertlein, Vol. 16, p. 141, 1927.

? Ostrea gallus Valenciennes, Voy. Venus, Coq., pl. 21, 1846, *fide* Dall, 1898.

Ostrea cerrasensis Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 35, 1866; p. 106, pl. 11, fig. 61, 1868-9.

Pliocene: Cedros Island, vicinity of Turtle Bay, Loreto, San Antonio Point, Maria Madre Island, Santa Antonita Point, all in Lower California, Mexico (Jordan and Hertlein; Hanna and Hertlein); "Saugus" near Piru, Santa Clara Valley (Jordan and Hertlein).
Pleistocene: San Quintin Bay, west coast of Lower California, Mexico (Dall, in Orcutt; Jordan).
Recent: Lower California south to Peru (Dall, 1914).

This species is nearly equivalve, of a reniform shape, and has large rounded plications which give the ventral margin great resistance against lateral thrusts. *Ostrea megodon* has been reported from the Burabo formation of the Dominican Republic by Maury, from the Miocene of Bowden, Jamaica, by Dall (1898), and from the Miocene of Costa Rica by Olsson; but Woodring (Carnegie Inst. Publ. No. 366, p. 60, pl. 6, figs. 12-14, 1925) points out differences in the Bowden form, which he renames *paramegodon*. The Caribbean species, however, appears to be closely related.

Ostrea cumingiana Dunker

Ostrea cumingiana Dunker, Zeitschrift f. Malak., Vol. 3, p. 48, 1846; Philippi, Abbild. Conch., Vol. 2, *Ostrea*, p. 81, pl. 1, figs. 1-4, 1846; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 352, 1857.

Ostrea jacobea de Rochebrune, Bull. Mus. Hist. Nat. Paris, Vol. 1, p. 241, 1895; not of Linnæus, Syst. Nat. Ed. 10, p. 696, 1758; Ed. 12, p. 1144, 1767.

Ostrea sinensis var. *cumingiana* Dunker, Lamy, Jour. Conchyl., Vol. 57, pp. 218, 219, 1909.

Ostrea fischeri Dall, Nautilus, Vol. 28, p. 1, 1914, new name for *O. jacobea* de Rochebrune, not Linnæus; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 141, 1927.

Pliocene: Espiritu Santo Island, Lower California, and Ceralbo Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Gulf of California and west coast of Mexico.

Lamy (1909) considered this oyster a variety of *Ostrea sinensis* Gmelin (Syst. Nat., Ed. 13, Vol. 1, p. 3335, 1790).[2] This latter species appears to be similar to "*Mytilus*" *hyotis* Linnæus but does not have tubular spines. Authentic specimens or the type of Dall's *O. tubulifera* should be carefully compared with *Ostrea hyotis* (Linnæus).

Ostrea amara Carpenter, 1857, *O. angelica* de Rochebrune, 1895, and *O. mexicana* Sowerby, 1871, should be compared with *cumingiana* Dunker, 1846.

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[1] Ann. Philos., Ser. 2, Vol. 9, p. 139, 1825; Hanley, Cat. Rec. Biv. Shells, p. 302, 1842; Sowerby, in Reeve's Conch. Icon., Vol. 18, *Ostrea*, sp. 1, pl. 1, 1871; Lamy, Journal de Conchyliologie, Vol. 57, p. 219, 1909. According to Lamy, *Ostrea lucasiana* de Rochebrune (Bull. Mus. Hist. Nat. Paris, Vol. 1, p. 241, 1895) is a further synonym of *prismatica* Gray. Sowerby, in Reeve, has a fine figure of *prismatica*, of which he considers *iridescens* a synonym.

[2] Figured by Hanley, Conch. Misc., *Ostrea*, pl. 3, figs. 9-12, 1854, and by Sowerby in Reeve's Conch. Icon., Vol. 18, *Ostrea*, pl. 3, fig. 5, 1870.

Ostrea heermanni Conrad

Ostrea heermanni Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 5, p. 267, 1855; U. S. Pacific R. R. Repts., Vol. 5, p. 326, 1855; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 685, 1898, his Carrizo Creek localities only, not his other localities nor his synonymy.

Ostrea heermani Conrad, Kew, Univ. Calif. Publ. Geol., Vol. 8, p. 46, 1914.

Ostrea heermanni Conrad, Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 467, pl. 22, figs. 7, 8, pl. 23, figs. 1, 2, 1926.

Pliocene: Carrizo Creek region (Conrad); Carrizo formation, lower division, all localities, upper division at Yuha Buttes, western Imperial County (Kew); abundant in many places in the Imperial formation of Coyote Mountain, western Imperial County (Hanna).

G. D. Hanna appears to be the only one who has figured this early described California species. He remarks: "Although this species has not been previously figured, so far as I have been able to determine, there is no mistaking the fact that Conrad had specimens of the only large circular oyster of the Coyote Mountain region. It is excessively abundant in many places and also excessively variable." (Hanna, 1926.)

Ostrea lurida Carpenter

Ostrea lurida Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 645, 1864; Jour. Conchyl., Vol. 12, p. 137, 1865; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 106, 1869; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 256, 1888; Keep, West Coast Shells, p. 164, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 193, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 102, 1903; U. S. Geol. Surv., Bull. 396, p. 167, pl. 30, fig. 12, Jan. 15, 1910; Arnold and Anderson, Bull. 398, p. 153, pl. 52, fig. 12, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, 1915; Martin, Vol. 9, p. 253, 1916; Nomland, Vol. 10, p. 219, 1917; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 24, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 18, 1921; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 50, pl. 37, figs. 10*a-b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 3, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 251, 252, 255, 1929.

Type specimen: In U. S. National Museum.

Type locality: Vancouver Island; Recent.

? Micoene: San Pablo formation of middle California (Clark, 1915).

Pliocene: Uppermost Etchegoin formation of Coalinga district (Arnold); common in the *Pecten coalingensis* and *Mya japonica* zones of Coalinga (Nomland); "Pico" near Ventura (Waterfall); Cedros Island and Turtle Bay, Lower California, Mexico (Jordan and Hertlein); upper Merced south of San Francisco (Martin).

Pleistocene: Rare in the lower San Pedro series of Deadman Island and San Pedro (Arnold); Pleistocene of Benecia, Solano County (*fide* Arnold, 1903); Tomales Bay, Marin County (Dickerson); lower San Pedro of Nob Hill cut, San Pedro (Oldroyd, 1925); "Saugus" formation near Ventura (Waterfall); foot of 26th Street, San Diego (Arnold, 1903; Stephens); Greeley Street; east side of Point Loma, common; two miles north of Del Mar; northeast end of Point Loma, all San Diego County (Stephens); exceedingly common in upper San Pedro series of San Pedro, Signal Hill, and Long Beach, Los Angeles County (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Sitka, Alaska, to Cape San Lucas, Lower California, Mexico (Dall, 1921).

This is a rather small species of an irregular ellipsoidal or elongate shape, sculptured with crude, low, irregular plications, or almost smooth except for irregularities of growth. The layers of the fossil shells are often easily scaled off if leaching has weakened the nacreous shell structure. It is very abundant at certain places. It has not been generally recognized from the Miocene; and the San Pablo formation record might have been based upon the young of some other species.

Ostrea palmula Carpenter

Ostrea ? ? conchaphila, var. *palmula* Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., pp. 163, 550, 1857.
Ostrea palmula Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 18, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 51, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 148, 151, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: "Pico" near Ventura (Waterfall).
Pleistocene: Lower Quaternary of Magdalena Bay and upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan); Santa Rosalia district, gulf side of Lower California, Mexico (collected by M. E. Touwaide).
Recent: Puget Sound to Gulf of California (Dall, 1921).

O. palmula has palm-like foliations on the outer margin, and a row of denticles which fit into the margin of the opposite valve. It is a small species, about two or two and a half inches long (50 or 60 mm.). Lamy[1] stated that this species may be identical with *O. spathulata* Lamarck[2].

Ostrea vespertina Conrad

Plate 12, Figures 1*a*, 1*b*

Ostrea vespertina Conrad, Jour. Acad. Nat. Sci. Phila., Ser. 2, Vol. 2, p. 300, 1854; U. S. House of Representatives, House Doc. No. 129, p. 15, July, 1855; U. S. Pacific R. R. Repts., Vol. 5, p. 325, pl. 5, figs. 36-8, 1856, reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 168, 1909; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 107, 1869; Arnold, U. S. Geol. Surv., Bull. 396, p. 77, pl. 24, figs. 4, 5, 1910; Bull. 398, pl. 46, same figures, 1910; Kew, Univ. Calif. Publ. Geol., Vol. 8, p. 46, 1914; English, Vol. 8, p. 210, 1914; Nomland, Vol. 10, pp. 219, 299, 300, 302, 1917; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, pp. 468, 469, pl. 26, figs. 1, 2, 3, 1926; Jordan and Hertlein, Vol. 15, pp. 212, 428, 429, 1926; Hanna and Hertlein, Vol. 16, p. 141, 1927.
? Ostrea amara Carpenter, Proc. Zool. Soc. London for 1863, p. 363, 1863.
Ostrea veatchii Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 34, pl. 11, fig. 59, 1866; Dall, Seventeenth Ann. Rept., U. S. Geol. Surv., Pt. 1, p. 844, 1896; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 63, questionably identified, 1903; Proc. U. S. Nat. Mus., Vol. 32, pp. 527, 544, pl. 49, fig. 1, 1907; Weaver, Wash. Geol. Surv., Bull. 15, p. 18, 1912; Dall, Nautilus, Vol. 28, p. 1, 1914; Vol. 32, p. 24, 1918; U. S. Nat. Mus., Bull. 112, p. 17, 1921; Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 49, 1926.

Miocene: Blakely formation, "lower Miocene" of western Washington (Weaver); Alka Island and Unga Island, Alaska (Dall, 1896); Santa Margarita, upper Miocene, north of Coalinga and questionably of the Tejon Hills, also San Pablo formation, upper Miocene, of middle California (Nomland, 1917).
Pliocene: Lower Fernando of Holser Canyon (English); lower Pliocene of Third Street Tunnel, Los Angeles (Arnold, 1907); lower Fernando of Fugler's Point, Santa Barbara County (Carson); Etchegoin formation of Coalinga district (Arnold); common in *Pecten coalingensis* and *Mya japonica* zones of Coalinga district Pliocene (Nomland, 1917); Imperial formation of Coyote Mountain, western Imperial County (Kew; Hanna); questionably, Pliocene of Russ School and Pacific Beach, San Diego (Arnold, 1903); Pico formation of southern California (Jordan and Hertlein); Cedros Island, Turtle Bay, and Elephant Mesa, west coast of Lower California (Jordan and Hertlein); Santa Antonita Point, Loreto, Coronados Island, Pond Island, San Jose Island, all Lower California, Mexico (Hanna and Hertlein); upper Pliocene of Maria Madre Island, Lower California (Jordan and Hertlein); very abundant in the normal facies of the middle Pliocene from Fernando Pass to Holser Canyon, Los Angeles County, S. D. S. N. H. localities 213, 214, 228, 268, 217, etc. (H. R. G.)
Pleistocene: Magdalena Bay, west coast of Lower California, Mexico (Dall, 1918, as *O. veatchii*).
Recent: Lower California and the Gulf of California, Mexico.

Jordan and Hertlein (1926) discuss this species and its probable relationship with other forms. In spite of Dall's conclusion, *O. veatchii* Gabb appears to be a synonym of Conrad's earlier described *O. vespertina*. *O. amara* Carpenter may be identical.

This species is a fluted oyster with a moderately thick shell which is sculptured with six to fifteen, irregular, rather angular plications which increase in number from the beak outward. It is of medium size, averaging about 50 to 75 mm. in length. It is distinguished from *O. lurida* Carpenter by its larger, thicker, more plicate shell; from *O. heermanni* Conrad by its smaller thinner shell; and from *O. atwoodi* Gabb by having both valves plicate instead of only one. It is similar and perhaps closely related to several Atlantic coast species, such as *O. haitensis* Sowerby, *O. sculpturata* Conrad, *O. subfalcata* Conrad, etc.

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[1] Jour. de Conchyl., Vol. 57, p. 220, 1909.

[2] Hist. Anim. s. Vert., Vol. 6, p. 206, 1819; Delessert, Rec. Coq. Lamarck, pl. 17, figs. 1*a*-*d*, 1841; Sowerby, in Reeve's Conch. Icon., Vol. 18, *Ostrea*, pl. 8, fig. 13, 1871.

Ostrea vespertina Conrad variety **sequens** Arnold

Ostrea vespertina Conrad, var. *sequens* Arnold, U. S. Geol. Surv., Bull. 396, p. 79, pl. 29, figs. 5, 6, January 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 51, same figures, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, 1915, listed questionably; Nomland, Vol. 10, p. 219, 1917.

"This species is smaller, thinner, more circular in outline, and decidedly less plaited than the typical *O. vespertino*. The right valve of *O. vespertina* var. *sequens* is less ornate than the same valve in *O. vespertino*." (Arnold).

Type specimen: U. S. National Museum, No. 165,545, a left valve.

Type locality: Northeast border of Kettleman Hills, Coalinga district; upper Pliocene.

Miocene: Lower San Pablo formation of middle California, listed questionably (Clark).

Pliocene: At the type locality and at several other localities in the upper part of the Etchegoin formation, just below the fresh-water Tulare Lake beds (Arnold: Nomland); very abundant in the last phases of marine deposition in the middle Pliocene of localities 256, 258, 262, etc., S. D. S. N. H., Santa Clara Valley, Los Angeles County (H. R. G.).

Arnold pointed out that this variety lived during the period of unstable conditions during the change from the inland sea of Etchegoin time to the fresh-water lake of Tulare time.

The present authors are not acquainted with the characters that distinguish this form from *Ostrea lurida* Carpenter.

Ostrea atwoodi Gabb

Ostrea atwoodii Gabb, Geol. Surv. Calif., Palæo., Vol. 2, section 1, pp. 33, 34, pl. 10, figs. 58, 58*a*, pl. 11, fig. 58*b*, 1866; Arnold, U. S. Geol. Surv., Bull. 396, p. 140, pl. 17, figs. 1, 2, 1910; Arnold and Robert Anderson, Bull. 398, pl. 39, same figures, 1910; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916; Nomland, Vol. 10, p. 219, 1917.

"Shell broad, irregular, thin; partly attached, sometimes by nearly the whole of the lower surface; free surface of lower valve marked by numerous irregular radiating ribs crossed by lines of growth; upper valves more squamose and not radiated (in the only specimen I have seen). Hinge broad at the base, triangular, not deep and sometimes slightly oblique; inner margin of the shell not denticulated. Muscular scar broad." (Gabb, original description.) Gabb's type appears to have been 55 or 60 mm. long and the same in width.

Miocene: "On San Lorenzo Creek, Monterey County; either Miocene or Pliocene" (Gabb); San Pablo formation of middle California, upper Miocene (Nomland).

Pliocene: Upper Jacalitos and lower Etchegoin of the Coalinga district (Arnold); common in the *Chione elsmerensis*, *Turritella nova* and *Pecten coalingensis* zones, lower and middle Pliocene, Coalinga region (Nomland); Etcchegoin of Sargent oil field (Martin).

Ostrea tayloriana Gabb

Ostrea tayloriana Gabb, Geol. Surv. Calif., Palæo., Vol. 2, sect. 1, pt. 1, p. 34, pl. 12, figs. 60, 60*a*, 1866, sect. 1, pt. 3, p. 106, 1868-9; probably not of Dall, Seventeenth Ann. Rept. U. S. Geol. Surv., Pt. 1, p. 844, 1896; nor of Dall, Washington Academy of Sciences, Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 113, 1904; reissued by the Smithsonian Institution, 1910; not of Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 428, pl. 33, fig. 3, 1926, = *O. erici*.

Type specimen: In the collection of the University of California.

Type locality: "From the Miocene; from San Marcos Pass, near Santa Barbara" (Gabb); now believed to be upper Eocene.

Eocene: At the type locality, probably upper Eocene.[1]

? Miocene: Atka Island, Pavlof Bay, Unga Island, and Kadiak Island (Dall, 1896); "Miocene Unga Island and near Pavlof Volcano on the Peninsula of Alaska" (Dall, 1904).

Dall united this form with unrelated species. It seems to have been confused with *O. idriaensis* Gabb. Dall's reports from the Alaskan Miocene are probably erroneous; and the specimens reported from the middle Pliocene of Lower California by Jordan and Hertlein have since been renamed *erici*.

Ostrea erici Hertlein

"*Ostrea tayloriana* Gabb," Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 428, pl. 33, fig. 3, 1926.
Ostrea erici Hertlein, Journ. Paleo., Vol. 3, p. 295, Sept., 1929.

Type specimen: In the collection of the California Academy of Sciences.

Type locality: Mouth of large arroyo northwest of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California, Mexico.

Pliocene: Cedros Island, and northwest of Elephant Mesa, west coast of Lower California, Mexico (Jordan and Hertlein).

This species should be compared with *O. chilensis* Philippi and *O. panzana* Conrad.

Superfamily PECTINACEA

Shell usually somewhat inequivalve, more or less circular, hinge line straight or nearly straight, often with wing-like extensions called ears; young shells with two muscle scars (dimyarian), adults usually with only one (monomyarian); shell structure semi-pearly, usually with some traces of a prismatic layer.

Family PECTINIDAE

Shell with the ears well developed; internal ligament inserted in a cardinal pit or series of radiating grooves under the beaks, sometimes in the adherent species externally prolonged in a notch between the beaks; very young shells dimyarian, with small taxodont teeth and a prismatic shell layer, indicating relationship with the *Pteriidæ* and the *Nuculidæ*, the teeth usually entirely obsolete in the adults, and the prismatic layer seldom showing, the adults monomyarian, with the ears dorsal and ventral instead of anterior and posterior.

Genus PECTEN Osbeck, 1765

Pecten Klein, 1753, pre-Linnæan.

Pecten Osbeck, "Dagbok öfver en Ostindisk Resa åren 1750-52, ... ," p. 299, Stockholm, 1757, pre-Linnæan; Ed. 2, revised by Osbeck and translated into German by J. G. Georgi, "Reise nach Ostindien und China . . . . ," p. 391, Rostock, 1765; Ed. 3, translated into English from the German by J. R. Forster, "A Voyage to China and the East Indies, ... ," Vol. 2, p. 100, London, 1771; Sherborn, Index Animalium, Section 2, *Pecten*, 1929.

Pecten Müller, Zoologiæ Danicæ Prodromus, pp. 31, 248, Havniæ, 1776, species cited include among others *Pecten maximus*, = *Ostrea maxima* Linnæus, and *Pecten islandicus* Müller.

Pecten, of various other early authors, in part: Da Costa, Brit. Conch., p. 140, 1778; Chemnitz, Neues Syst. Conch. Cab., Vol. 7, pp. 261-356, pls. 60-68, 1784; etc.

Hinnites Defrance, Dict. Sci. Nat., Vol. 21, p. 169, 1821, species in the original list *H. cortesyi* Defrance and *H. dubuissoni* Defrance; Deshayes in Lamarck, Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 7, p. 148, 1836; Herrmannsen, Ind. Gen. Malac., Vol. 1, p. 533, 1846-7, type not cited; Gray, Proc. Malac. Soc. London, p. 201, 1847, type cited *H. corteysii;* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, pp. 689, 699, 711, 1898.

Hinnita Férussac and Deshayes, Tableaux Systematique des Animaux Mollusque, ... etc., Tabl. Syst. Généraux, p. xl, 1822; Gray, Ann. Phil., N. S., Vol. 12, p. 103, August, 1826; Menke, 1828 (*fide* Herrmannsen).

Hinnus Gray, Ann. Phil., N. S., Vol. 12, p. 362, Nov., 1826; Sowerby, Syst. Index Min. Conch. Gt. Brit., p. 244, 1835; Wood, Ann. and Mag. Nat. Hist., Ser. 1, Vol. 6, p. 253, 1841, another emendation of *Hinnites*.

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[1] Woodring (Trans. San Diego Soc. Nat. Hist., Vol. 6, p. 159, 1930) reports *O. tayloriana* in the *Turritella variata* zone, upper Eocene, of the Santa Ynez Mountains, near Gaviota Pass, Santa Barbara County.

Type (by monotypy), *Pecten adscensionis* Osbeck, Recent, Cross Bay, Ascension Island, south Atlantic, in 24 fathoms.

Shell nearly always somewhat inequivalve, but, with the exception of the ears, usually approximately equilateral, suborbicular; hinge line straight, the ears well developed, the ventral one of the right valve more or less separated from the main body of the shell by a byssal notch; sculpture normally of external radiating ribs or striæ; resilium triangular, situated in a pit in the middle of the inside of the hinge, in heavy-shelled or short-hinged species sometimes well-developed grooves and ridges diverging from the apex of the resilial pit; the single adductor muscle large, rounded, dorsal, being the strongly developed posterior adductor of the young stages.

Geologic range: Carboniferous to Recent (Jackson).

Distribution: World wide.

The Pectens or scallop shells constitute a single distinct and very important group. Their phylogeny along with that of related groups has been very carefully worked out by R. T. Jackson in his classic work on the "Phylogeny of the Pelecypoda."[1] In 1897 A. E. Verrill wrote a discussion of the characters of the genus, dividing it up into many genera, subgenera, and sections on the basis of very minor characteristics, and proposing many new names[2]. The next year Dall prepared a summary of the subgenera and sections of the genus and reviewed many of our Pacific coast species[3]. Soon afterward Ralph Arnold compiled a monograph of the "Tertiary and Quaternary Pectens of California" which has been the foundation of all subsequent work on west American Pectens[4]. Studies of variations carried on in the East and in Europe by C. B. Davenport and others have been of considerable importance in showing the extent of variation possible within a single species.[5]

Fossil as well as living species show very wide variations. The study of these variations is indispensable for an understanding of the range and distribution of species and should be pursued by anyone who is considering the naming of new species or varieties. Because of the failure to recognize the variability of Pectens, our common species are encumbered with long lists of synonyms and varieties of doubtful value. The variable characters are: convexity of valves; thickness of shell; size; shape, number, and spacing of ribs; relative length of hinge line; size of the apical angle; amount of obliquity of the valves; ratio of altitude to width; etc. The characters mentioned first are the most variable: the convexity may be twice as much in one individual as in another; the thickness and size vary with age, with the temperature, depth, and salinity of the water; the ribs may vary from low and rounded to high and square, and some specimens may have half again as many as others; the relative length of the hinge line depends on whether deposition has taken place last on the ears or on the free margins of the valves; the apical angle varies somewhat in absolute size and on very convex individuals appears larger because the beak is tilted downward; some individuals are considerably more drawn out dorsally than others, giving the shell an oblique appearance; and the ratio of the altitude to the width is also variable. Some characters vary together: the width of the smooth lateral areas outside of the last ribs is greatly influenced by the convexity of the individual, as is also the curvature of the ears; individuals with heavier shells are apt to have stronger, sharper ribs, except that gerontic types often greatly increase the thickness of the shell and at the same time lose the definiteness of their sculpture. In the following classification the forms that have received distinct names but are not known to have any stratigraphic significance and are found to have many combinations of intergrading characters (as a complicated aggregate of related variations should be expected to have) are grouped under a single specific name, thus stressing their relationship, but are distinguished as varieties lest they be found at any time to be of value. If they all were to be considered distinct, we should eventually, to be consistent, have a separate name for every form that lived in every little bay and along every stretch of shore where the living conditions were slightly different, and geologic correlations (the chief object of paleontologic study) would be very difficult.

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[1] Jackson, Robert Tracy: "Phylogeny of the Pelecypoda, the Aviculidæ and their Allies," Mem. Bost. Soc. Nat. Hist., Vol. 4, pp. 277-400, 1890.

[2] Verrill, A. E.: "A Study of the Family Pectinidæ, with a Revision of the Genera and Subgenera," Trans. Conn. Acad. Sci., Vol. 10, pp. 41-96, 1897.

[3] Dall, William Healey, in the "Tertiary Fauna of Florida," Trans. Wagner Free Inst. Sci., Phila., Vol. 3, pp. 689-758, 1898.

[4] Arnold, Ralph: "Tertiary and Quaternary Pectens of California," Prof. Paper 47 U. S. Geol. Survey, pp. 1-264, pls. 1-53, 1906.

[5] Davenport, C. B.: "On the Variation of the Shell of Pecten Irradians Lamarck from Long Island," Amer. Naturalist, Vol. 34, pp. 863-877, 1900.

——————: "A Comparison of some Pectens from the East and West Coasts of the United States," Mark Anniversary Volume, pp. 123-136, 1903 (Henry Holt & Co., New York).

——————: "Quantitative Studies in the Evolution of Pecten. III. Comparison of Pecten Opercularis from Three Localities of the British Isles," Proc. Amer. Acad. Arts and Sci., Vol. 39, pp. 124-159, 1903.

—————— and Hubbard, M. E.: "Studies in the Evolution of Pecten. IV. Ray Development in Pecten Varius," Journ. Exp. Zool., Vol. 1, pp. 607-616, 1904.

——————: "Evolution without Mutation," Journ. Exp. Zool., Vol. 2, pp. 137-43, 1905.

Jackson has pointed out that in monomyarians like the Pectens and oysters the animal has assumed a position within the shell at right angles to that occupied by dimyarian pelecypods. As a result the ears become ventral and dorsal instead of anterior and posterior respectively, and the hinge line is anterior while the free ends of the valves are posterior. Since to call them so is biologically correct and helps to convey a clearer picture of the nature of the organism, it seems wise to follow Jackson's lead. The byssus is always ventral. The right valve is the valve with the byssus on the right (and bears the byssal notch), the left is the valve with the byssus on the left. The rest of the descriptive terms used here are as given in the introduction to Arnold's monograph.

There has been a tendency among recent writers to separate the genus *Pecten* as here treated into several, sometimes many, distinct genera, restricting the name *Pecten* to a very limited part of the group. There are good reasons for subdividing the genus, for it must be admitted that the extreme forms are sometimes very dissimilar, that it is a long jump from *Lyropecten*, for instance, to *Pseudamussium*. Nevertheless, our generic lines are drawn principally for convenience at the points where groups are most easily separated, and it is difficult to see what useful purpose it would serve to break up and scatter to the winds this well-known and long-recognized genus. Geologists and others who know only a little of conchology can now recognize and talk with confidence about Pectens; but if instead of one well-marked genus, they were confronted with many names recognizable generically only by specialists who have well-preserved material, matieral good enough usually so that the species could be recognized as easily as the genus, the nomenclature would no longer be useful to them. The Pectens are such an important group that it is well to handle them conservatively. Furthermore, the present lack of information about the exact nature of the type species and the consequent uncertainty in the nomenclature of some of the subgenera (which would be genera if the group were broken up) make it unwise for the time being to upset the long-established custom of assigning all the Pectens to a single genus.

If later the present arrangement of the subgeneric nomenclature becomes stabilized, most of the species commonly known as *Pecten* can be left under that name, and it may be found useful to recognize as additional genera *Janira*, *Amusium*, *Propeamussium*, and *Pseudamussium*. Such a subdivision of the Pecten group would do much less harm than the subdivision according to the arrangement of subgenera that has generally been in use up to this time, for *Pecten, s. s.*, *Pallium*, *Lyropecten*, *Vertipecten*, *Patinopecten*, and

Aequipecten would still remain as subgenera, and only the forms with more strikingly different appearances would be separated. As *Janira* and *Amusium*, despite their dissimilar appearances, are really very closely related, it is possible that *Janira* should be classified as a subgenus of *Amusium*.

For the last fifty or seventy-five years many writers have been considering the group of species with the left valve flat, or nearly flat, or concave, typified by *Ostrea maxima* Linnæus, as the typical subgenus of *Pecten*. However, most of the early writers, who used the term *Pecten* in a broad sense, included under it a large number of species that belong to the group with both valves inflated. As the latter group is the more important, with a greater variety of forms and many more species, it was natural to think of it as the normal group, and of *Pecten maximus* and its relatives as specialized derivatives, which they are. Jackson in 1890, and, even later, others who have been more interested in morphology and phylogeny than in nomenclature have assumed that the larger group should bear the name. At least two other generic names have been proposed to include *Pecten maximus* because it differed from what was thought to be a normal *Pecten*, and these names have at times had considerable use. Thus it is not surprising that Osbeck, who was familiar with the pre-Linnæan usage of the well-known term, should apply it to a species of the larger group. We may be glad that he did, for it enables us to retain *Pecten* for the larger part of the shells that have been so called throughout most of conchological history, even though the genus as here used be divided up.

The only unfortunate feature of Osbeck's usage of the name *Pecten* lies in the brevity of his description and the remoteness of the type locality of his type species, which make it difficult to discover on short notice the exact characters of the species. The information given by Osbeck is, however, quite sufficient to indicate the subdivision of the genus to which his species belongs and to enable later workers to identify it and ascertain its characters more precisely. Osbeck writes (Vol. 2, p. 77 of the English edition):

"We steered from W. by N. to get the longitude of *Ascension Island*, near which we sailed in the forenoon; and at last cast anchor in the *Cross-bay* on the same island, with twenty-four fathoms ground."

After describing the plants and animals that he found while the ship remained a few days in Cross Bay, he writes (p. 100):

"After we had got all our men on board again, and 41 tortoises on the deck, we weighed anchor. With the cable we pulled up a piece of coral, on which a red shell (*Pecten Adscensionis*) was growing, which on its valves represented many branches. We took it with us, and at present it is preserved in one of the greatest cabinets of natural curiosities in Sweden."

As *Pecten* had long been in use for scallop shells, even in Osbeck's time, it is evident that Osbeck had a species of scallop or a scallop-like form that had been growing to a piece of coral and on which there were many ribs, multiplying by division. The many ribs and the sessile habit indicate that it was a form related to *Chlamys* but belonging to the section that was formerly called *Hinnites*. The red color may be of help in identifying the species or variety. It may be a reddish variety of *P. multistriatus* (Poli) or of *P. distortus* Da Costa + *sinuosus* (Gmelin), or it may be *Hinnites corallinus* Sowerby, or an entirely distinct island species. In any case the definite type locality and meager fauna of Ascension Island make the ultimate precise identification of the species practically certain, if indeed the type specimen cannot be located "in one of the greatest cabinets of natural curiosities in Sweden." Since Osbeck is the first writer to use *Pecten* binomially, it is here proposed to follow his usage as nearly as it can now be ascertained.

There is no question about the nomenclatorial availability of Osbeck's names. The German edition is not merely a reproduction or translation of a pre-Linnæan work, for it had been carefully revised by its author, as is shown by the following quotation from Mr. Forster's preface to the English edition:

"A word or two I must say in regard to the translation, which is made from the *German*, and not from the original *Swedish;* but as Mr. Osbeck not only revised the *German* translation, but also made some additions to it which are not found in the original *Swedish* edition, it is rather an advantage to the work than a prejudice." (English edition, Vol. 1, p. x.)

Furthermore, Osbeck is strictly binomial in all three editions. He describes many plants, birds, fishes, and other animals, often going into considerable detail, and in the case of the plants sometimes adds illustrations. It is unfortunate that he was not equally interested in invertebrate animals, or we might have had a fuller description of *Pecten adscensionis.* However, we must agree with Sherborn that Osbeck's *Pecten* is nomenclatorially available and must be dealt with. Osbeck was a pupil of Linnæus, and after his work was published Linnæus wrote him a letter, complimenting him especially on his nomenclature:

"You, Sir, have every where travelled with the light of science: you have named every thing so precisely, that it may be comprehended by the learned world; and have discovered and settled both the genera and species. For this reason, I seem myself to have travelled with you, and to have examined every object you saw with my own eyes." (English edition, Vol. 2, pp. 127-128.)

Subgenus **PECTEN**, s. s.

Shell with valves moderately and nearly equally inflated, ribs small and numerous, often gathered into many small bundles or fascicles, spinose or covered with microscopic lattice-like sculpture; hinge line short, ventral, ears large and extended, byssal notch deep and broad, ctenolium (pectinidial teeth) strong, dorsal ears small, oblique.

Geologic range: Triassic to Recent.

Distribution: World wide.

This subgenus appears to represent the main stock from which all the other modern subgenera have been derived. It is possible, however, that, as at present restricted, the early Mesozoic forms could not be included, or that the other subgenera instead of being derived directly from this one may have evolved along with it from a small thin-shelled group like *Entolium* Meek (Carboniferous to Cretaceous) or from *Pseudamussium.* The many fine radial ribs distinguish the typical subgenus, as well as the form of the ears.

Section Pecten, s. s.

Shell up to advanced youth like that of the section *Chlamys*, later becoming sessile and irregular, in which stage the resilial pit is elongated and the whole shell is thickened, becoming oyster-like.

These sessile forms, phylogenetic derivatives of the section *Chlamys,* have often been treated as belonging to a distinct genus, being placed sometimes even in a different family; but the reason for this treatment is that the two look very differently, not that they are genetically separated. The single Pacific coast species appears to have specific relationships with *Pecten hastatus,* being descended perhaps from the same Eocene ancestor, from some form like *P. proavus* Arnold. The lower Miocene specimens have a short sessile stage and are difficult to separate from species of *Chlamys*; and the young of the living form has too many characters in common with *hastatus* to allow the hypothesis to sound plausible that all the *specific* resemblances are coincidences. It seems highly probable and in accord with the natural facts that each of the species of sessile Pectens, which have appeared from time to time in geologic formations dating from the Triassic to the Recent, has individually separated from the main Pecten stock and hence has no particular relationship with the others. If this be so, the sessile habit is merely of specific, hardly even of sectional, importance; and to be entirely consistent we should not separate *Chlamys* from *Pecten*, s. s., at all. For the sake of convenience, however, the name *Chlamys* is here employed in a sectional or pseudosectional sense.

According to Blainville's figures[1] the species *cortesyi*, described as a fossil from Plaisantin, Italy, is very similar to *multirugosus*, and this fact would be surprising if it were not for the increasing accumulation of evidence to show that migration of mollusks between California and Europe in the Miocene was possible and that a number of species in the two regions are either the same or very closely related. On the other hand, the major part of the growth of a sessile form of *Pecten* is so irregular and is so much determined by the environment that the specific relationships can only be seen by examining the young *Chlamys* stage. If an examination of the young of *cortesyi* should show that it is descended from a different species of *Chlamys*, it would be desirable to have a different sectional name either for the Pacific coast or for the Italian species, or both; and *Hinnita* Gray 1826 with the type *Lima gigantea*, as noted by Gray in 1847, would be appropriate for the Pacific species, were it not for the earlier usage of *Hinnita* by Férussac and Deshayes, probably for the Italian species, before the Pacific species was known.

In this connection, the discussion by Bucquoy, Dautzenberg, and Dollfus[2] of the relationship between *Pecten multistriatus* (Poli) and *P. distortus* Da Costa + *sinuosus* (Gmelin) is very interesting. The authors give good figures of the two forms and explain that they may be only varieties of the same species, being indistinguishable until the form *distortus* attaches itself and becomes a sessile or typical *Pecten*. They think that the question of whether or not a given individual will attach itself may be determined by the environment. Perhaps *distortus* is a normal *Chlamys* just changing over into a typical *Pecten*.

Pecten (Pecten) multirugosus Gale

Plate 11, Figures *5a*, *5b*

Lima gigantea Gray, Ann. Phil., New Series, Vol. 9, p. 139, 1825, not *Plagiostoma* (= *Lima*) *gigantea* Sowerby, Min. Conch. Gt. Brit., Vol. 1, p. 176, pl. 77, 1812; Wood, Catalogue Suppl., pl. 2, fig. 7, inedited, 1825 or 26 (*fide* Gray).

Hinnita gigantea Gray, Ann. Phil., New Series, Vol. 12, p. 103, 1826.

Not *Pecten giganteus* Münster in Goldfuss, Petrifacta Germaniæ, Ed. 1, Vol. 2, pt. 4, p. 48, pl. 90, fig. 14, 1834; Ed. 2, p. 46, pl. 90, fig. 14, 1862.

Hinnites giganteus Gray, Sowerby, Zool. Journ., Vol. 3, p. 70, 1827; Thes. Conch., Vol. 1, *Hinnites*, p. 80, pl. 20, figs. 5-7, 1843; Reeve, Conch. Icon., Vol. 8, *Hinnites*, pl. 1, fig. 3, 1853; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 164, 193, 233, 290, 312, 350, 351, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 522, 527, 528, 534, 536, 539, 540, 645, 665, 683, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 105, 1868-9; Whiteaves, Trans. Roy. Soc. Canada, Vol. 4, sec. 4, p. 119, 1887; Cooper, Seventh Ann. Rept. Calif. St. Mineralogist, p. 243, 1888 (Santa Rosa Island occurrence excepted, *fide* Arnold); Keep, West Coast Shells, p. 165, fig. 138, 1888, 1892; Weymouth, Calif. Fish and Game Comm., Fish, Bull. No. 4, p. 25, pl. 1, fig. 3, pl. 2, figs. 1, 2, 1920; Dall, Bull. 112 U. S. Nat. Mus., p. 20, 1921; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 21, pl. 30, figs. 1*a*, 1*b*, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 63, pl. 25, figs. 1*a*, 1*b*, 1924 (but not from the "Pliocene of Santa Rosa Island," *fide* Arnold); Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

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[1] Blainville, Man. Malac., p. 524, Atlas pl. 61, fig. 1, 1825. *Hinnites cortesyi* Defrance is the type of *Hinnites* Defrance, which now falls as a synonym of *Pecten*, *s.s.*

[2] B., D., and D., Les Mollusques Marins du Roussillon, Vol. 2, pp. 104-109, 1889.

Hinnita poulsoni Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, p. 182, pl. 14, October, 1834, not *Pecten poulsoni* Morton, Synopsis of the Organic Remains of the Cretaceous Group of the United States, p. 59, pl. 19, fig. 2, Philadelphia, published early in 1834 (the preface dated January 1),—a common Claiborne species.

? *Pecten comatus* Valenciennes, Voyage of the Venus, pl. 18, fig. 2, Paris, 1846, not *Pecten comatus* Münster in Goldfuss, Petrifacta Germaniæ, Ed. 1, Vol. 2, pt. 4, p. 50, pl. 91, fig. 5, 1834; Ed. 2, p. 47, pl. 91, fig. 5, 1862; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 528, 1864.

Pecten (*Hinnites*) *giganteus* Gray, Küster and Kobelt, Conch. Cab., Vol. 17, Pt. 2, sp. 228, pl. 65, figs. 9, 10, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 115, 1903; Keep, West Amer. Shells, p. 42, fig. 22, 1904; Arnold, Prof. Paper 47, U. S. Geol. Survey, p. 93, in part, pl. 29, figs. 2, 2*a*, not fig. 1, 1906; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 45, 1916; Nomland, pp. 212, 219, 1917; Kew, Bull. 753 U. S. Geol. Survey, p. 78, 1924.

Not "*Pecten* (*Hinnites*) *giganteus* Gray", Eldridge and Arnold, Bull. 309, U. S. Geol. Survey, p. 17, pl. 32, fig. 1, 1907 (= *Spondylus perrini* Wiedey, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 138, pl. 17, figs. 6, 7, 1928).

Pecten (*Chlamys*) *multirugosus* Gale, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 92, 1928.

Shell of young a *Chlamys*, having numerous small, somewhat spinose ribs, those of the right valve low and irregular but arranged roughly in 20 to 22 paired fascicles, those of the left valve with every fourth or fifth to the number of 10 or 11 accentuated above the others and bearing more prominent spines; ears like those of *P. hastatus* at a similar age; adult shell attached by the right valve, which usually loses almost immediately all its character, left valve continuing more or less irregularly with the same sculpture, having the 10 or 11 prominent rows of spines, and soon developing as intercalaries 10 or 11 more, almost as prominent, with sometimes a tertiary set; hinge rough and irregular, the cartilage pit becoming greatly elongated in a direction transverse to the hinge line.

Dimensions (rough average of living specimens): Altitude 105 mm.; length 95 mm.; length of hinge 55 mm.; diameter of two valves 40 mm.

Type specimen: No. 5 in the type collection of the San Diego Society of Natural History.

Type locality: San Diego; Recent.

Pliocene: Carrizo Creek district, Imperial Co., Calif. (Arnold); Pacific Beach, San Diego (Arnold); Ventura and Los Angeles counties (Cooper, Kew); middle Pico, middle Pliocene of loc. 228 S. D. S. N. H. southeast of Pico Canyon, one medium-sized left valve (H. R. G.); Fourth and Broadway, Los Angeles (Moody); upper Pico, upper Pliocene of loc. 225 S. D. S. N. H. between Timber Canyon and Santa Paula Creek, Ventura Co., one large left valve (H. R. G.); ? "Pleistocene" of Santa Barbara (Cooper).

Pleistocene: Tomales Bay, Marin County (Dickerson); Santa Barbara to San Diego (Cooper); upper and lower San Pedro series of San Pedro, Los Angeles Co. (Arnold); "Saugus," of Ventura Co. (Waterfall).

Living: Aleutian Islands, Alaska, to Magdalena Bay, Lower California (Dall).

Variety **multirugosus**, s. s.

Shell when young more nearly circular in shape than that of *P. hastatus*, beginning to become irregular at an early stage, when still only 15 to 25 mm. in altitude.

Pecten (Pecten) multirugosus variety **crassiplicatus** Gale

Hinnites crassa Conrad, U. S. Pacific Railroad Survey, Reports, Vol. 7, Pt. 2, p. 190, pl. 2, figs. 1, 2, 1857, description reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 181, 1909; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 595, 1864; not *Pecten crassus* A. Risso, Histoire Naturelle des Principales Productions de l'Europe Méridionale, Vol. 4, p. 300, Nov., 1826.

[*Pecten*] *Hinnites crassus* Conrad, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 711, 1898.

"*Pecten* (*Hinnites*) *giganteus* Gray," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 93, in part, pl. 29, fig. 1 only, a figure of Conrad's type, 1906; Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 300, 304, in part, 1917.

"*Hinnites giganteus* Gray," Arnold, Bull. 396, U. S. Geol. Survey, p. 21, pl. 10, fig. 2, Jan. 15, 1910; Arnold and Anderson, Bull. 398, p. 94, pl. 32, fig. 2 (same figure), 1910.

Pecten (*Chlamys*) *multirugosus* variety *crassiplicatus* Gale, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 93, 1928, new name for *crassus* Conrad.

Shell like that of the typical variety but usually with the *Chlamys* stage lasting longer, lasting until the shell is 25 or even sometimes 45 mm. in altitude, the young shell relatively higher than long, practically the same shape as *P. hastatus*, the free valve of the adult usually having fewer and coarser plications.

Dimensions: Much like those of the typical variety, very variable.

Type specimen: No. 13,336 in the U. S. National Museum.

Type locality: Santa Margarita formation, of the Salinas Valley, middle California.

Middle Miocene: (Arnold, 1910).

Upper Miocene: Santa Margarita formation, type locality (Conrad); north of Coalinga, Fresno Co. (Arnold; Nomland).

Dall and others have thought that it might be possible to separate the upper Miocene form described as *crassa* from the common Pliocene to Recent species formerly known as *Pecten giganteus* (Gray), but the distinction is still of doubtful significance. This older form of attached *Pecten* resembles even more closely than the living form *P. hastatus* and its upper Miocene relatives here grouped under *P. bartschi*. It is more than likely that the paratypes of *P. hodgei* Hertlein are the young of *crassiplicatus*, though it is difficult to be sure where the type belongs. Intergradations between *crassiplicatus* and *bartschi*, and between *bartschi* and *hastatus* in the upper Miocene make the distinctions very difficult, although of course, as soon as the shell shows evidence of attachment it should be assigned to *crassiplicatus*. Some of the other forms cited questionably in the synonymy of *P. bartschi* may be young *Hinnites* also, and it is possible that one of these names should be used instead of *crassiplicatus*. There is almost enough material already collected to work out genetic series from the Eocene *proavus* Arnold through *bartschi* to *hastatus* and from *proavus*, perhaps also through *bartschi*, to *crassiplicatus* and *multirugosus*.

Section CHLAMYS Bolten, 1798

Chlamys Bolten, Mus. Boltenianum, p. 161, 1798, species cited include, among many others, (1) *C. cinnabarina*, under which references are given to *Ostrea islandica* Gmelin, sp. 55, Chemnitz, Vol. 7, pl. 65, figs. 615, 616, and (2) *C. islandica*, under which no references are given; Herrmannsen, Ind. Gen. Malac., Vol. 1, p. 231, 1846-47, type designated, *Pecten islandicus* Linnæus, referring almost certainly to Gmelin's edition of Linnæus, which was included in the Boltenian references; Meek, U. S. Geol. Surv. of the Territories, Vol. 9, p. 23, 1876, accepts Herrmannsen's designation of type.

Type (by subsequent designation, Herrmannsen, 1846-47), *Pecten islandicus* (Linnæus) = *Ostrea islandica* Gmelin in Linnæus, Syst. Nat., Ed., 13, p. 3326, 1791 = *Pecten islandicus* Müller, Prodr. Zool. Dan., p. 248, 1776; Recent, circumboreal.

Ribs small and numerous, spinose, or rounded and covered with cross-hatching; shell never becoming sessile or irregular.

According to the dictionary and to Bolten's usage, the word *Chlamys* is feminine.

Pecten (Pecten) islandicus Müller

Plate 11, Figures 1*a*, 1*b*

Pecten islandicus Müller, Zool. Dan. Prodr., No. 2990, p. 248, 1776; Chemnitz, Neues Syst. Conch. Cab., Vol. 7, p. 304, pl. 65, figs. 615, 616, 1784; Lamarck, Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 7, p. 145, 1836; Sowerby, Thes. Conch., Vol. 1, p. 75, pl. 17, figs. 159, 160, 161, 1842; Middendorff, "Beiträge zu einer Malacozoologia Rossica," Vol. 3, Mém. Acad. Imp. Sci., St.-Pétersbourg, Ser. 6, Vol. 6, Pt. 3, p. 12 (*cir.*), 1849; Wood, Mon. Palæo. Soc., Vol. 4, "Mon. Crag Moll.", Vol. 2, p. 40, pl. 5, fig. 1, 1851; Küster and Kobelt, in Martini-Chemnitz, Syst. Conch. Cab., Second Series, Vol. 17, Pt. 2, *Spondylus* und *Pecten*, No. 24, p. 59, pl. 16, figs. 1, 2, p. 105, pl. 30, figs. 1-6, 1888; Brögger, Norges Geol. Undersögelse, No. 31, p. 228, fig. 23, pl. 5, figs. 1*a-d*, 1901; Dall in Moffit, Bull. 533 U. S. Geol. Survey, pp. 45, 46, 47, 1913.

Ostrea cinnabarina Born, Testacea Musei Cæsarei Vindobonensis, p. 103, 1780 (*fide* Deshayes in Lamarck, 1836); Dillwyn, Cat. Rec. Shells, Vol. 1, p. 256, 1817.

Ostrea islandica Müller, Fabricius, Fauna Grönlandica, p. 415, 1780; Gmelin in Linnæus, Syst. Nat., Ed. 13, p. 3326' 1791.

Pecten rubidus Martyn, Univ. Conch., Vol. 2, pl. 153, fig. 1, 1784; not "*Pecten rubidus* Martyn" of Hinds and Middendorff (*fide* Dall, Nautilus, Vol. 27, p. 122, 1914).

Ostrea demissa Solander, Mus. Calonnianum, p. 52, 1797.

Chlamys cinnabarina, Bolten, Mus. Boltenianum, p. 161, 1798.

Chlamys islandica Bolten, *loc. cit.*

Pecten pealii Conrad, Amer. Marine Conch., Vol. 1, p. 12, pl. 2, fig. 2, 1831.

Pecten fabricii Philippi, Abbildungen und Beschreibungen neuer oder wenig gekannter Conchylien, Vol. 1, p. 101, *Pecten*, pl. 1, fig. 5, January, 1844.

Not "*Pecten islandicus* Müller," Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 257, 1888 (*fide* Arnold, = variety *jordani* Arnold).

Chlamys islandica Chemnitz, Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 72, pl. 16, figs. 2-5*b*, pl. 20, fig. 9, pl. 21, fig. 2, 1897.

Pecten (*Chlamys*) *islandicus* Müller, Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, pp. 708, 735, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 113, pl. 45, figs. 1, 1*a*, 1906; Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Univ. Wash. Publ. Puget-Sound Biol. Sta., Vol. 4, p. 18, pl. 24, figs. 1, 2, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 54, pl. 8, figs. 1, 2, 1924.

Pecten (*Chlamys*) *islandicus* Müller n. var. ?, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 84, 1929.

Shell large, of medium thickness, subcircular, equilateral except for the ears, somewhat higher than long, valves with very low convexity, anterior margins back of the ears (or sides as they are often called) only slightly incurving; sculpture of numerous rounded, somewhat flat-topped, narrow ribs, finely imbricated when fresh, smooth when worn, very variable in number, multiplying with growth by bifurcation and intercalation, more by bifurcation on the right valve, more by intercalation on the left valve, usually twenty-five to thirty-five primary ribs on each valve, more distant on the left, the interspaces finely cross-hatched; hinge line about half the length of the shell, variable, the ventral ears about twice as long as the dorsal, the byssal ear rounded at the extremity, sculptured with five or six major radiating riblets and some intercalaries, the byssal scar taking up less than a third the width of the ear, notch only of moderate depth, other ears sculptured with seven or eight radiating riblets.

Dimensions: Altitude 82 mm.; length 75 mm.; length of hinge line 37.5 mm.; convexity of the two valves 27 mm., the left a little more convex than the right.

Type specimen: At Copenhagen (?).

Type locality: Iceland.

? Oligocene-Miocene: As *P. branneri* and *P. washburnei* of middle California and Oregon (Arnold).

Pliocene: Raised beaches at Nome, Alaska (Dall, 1913); uppermost Pliocene of Ventura Co., California (Waterfall).

Pleistocene: "Pliocene" of Deadman Island, San Pedro (Arnold); boulder clays of the northwest American coast, Alaska, British Columbia, also New England and New Brunswick (Dall); Clyde beds of England (Wood).

Living: Arctic Ocean to Kamchatka and Puget Sound on the west, to Chesapeake Bay on the east (Dall); Scandinavia and north Scotland (Wood).

This species is characterized by its large size when adult, by its large number of irregularly sized ribs, and by the reticulated interspaces. According to Arnold, there were in 1906 only two authentic specimens known from California, both of them coming from the "Pliocene" of Deadman Island. It seems probable, however, that the specimens described by Waterfall from the upper Pico, Santa Barbara zone, of Ventura County, should be assigned to the typical variety. From the descriptions and illustrations of *Pecten branneri* and *P. washburnei* Arnold,[1] there is practically nothing by which these forms can be distinguished from the typical variety of *islandicus*. The ears of *branneri* are not large for a fragment of a large specimen. However, it is possible that the narrower apical angle of *branneri* and the fewer, stronger ribs might be of significance and might serve to distinguish it. In any case, those forms are almost surely the ancestors of the living *islandicus,* and are closely related to the Maryland Miocene *P. marylandicus* Wagner,[1] to say nothing of the Oligocene forms of the Northwest.

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[1] *Pecten* (*Chlamys*) *branneri* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 55, pl. 3, figs. 9, 10, 11, 1906.
Pecten (*Chlamys*) *washburnei* Arnold, *op. cit.*, p. 119, pl. 45, fig. 2, 1906.

Variety **islandicus,** s. s.

Shell large, the altitude noticeably greater than the length; ribs numerous, narrow, rounded, slightly imbricated.

Pecten (Pecten) islandicus Müller variety **hindsii** Carpenter

"*Pecten fabricii* Philippi" Gould (*fide* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 574, 1864).

"*Pecten rubidus* Martyn" Hinds, Zool. Voy. Sulphur, Moll., p. 61, pl. 17, fig. 5, 1844 (*fide* Carpenter, *op. cit.*, p. 606).

Pecten (? var.) *hindsii* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 645, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 92, 131 (bottom pagination), 1872.

Pecten (*Chlamys*) *hericeus* var. *hindsii* Carpenter, Whiteaves, Trans. Roy. Soc. Canada, Vol. 4, sec. 4, p. 119, 1887; Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 709, 1898.

Pecten (*Chlamys*) *hericeus* var. *navarchus* Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 708, 1898; Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 121, 1904, reissued by the Smithsonian Inst., 1910.

Pecten (*Chlamys*) *hastatus* var. *hindsii* Carpenter, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 111, pl. 43, figs. 2, 2*a*, 1906.

Pecten (*Chlamys*) *hastatus* var. *navarchus* Dall, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 112, pl. 43, figs. 1, 1*a*, 1*b*, 1906.

Pecten (*Chlamys*) *hindsii* Carpenter, Dall, Bull. 112 U. S. Nat. Mus. p. 18, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 17, pl. 23, figs. 3, 4, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 53, pl. 7, figs. 3, 4, 1924.

Pecten (*Chlamys*) *hindsii* var. *navarchus* Dall, Bull. 112 U. S. Nat. Mus., p. 18, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 17, pl. 26, figs. 2, 3, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 54, pl. 4, figs. 2, 3, 1924.

Pecten (*Chlamys*) *islandicus picoensis* Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 79, 83, pl. 5, figs. 2, 4, 1929.

Pecten (*Chlamys*) *washburnei venturanesis* Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pecten (*Chlamys*) *venturaensis* Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 84, pl. 6, fig. 4, 1929.

Shell like that of the typical variety, but smaller, relatively longer; ribs somewhat more regular and fewer, usually not imbricated, covered with a minute lattice-like structure, those of the right valve multiplying principally by bifurcation, those of the left principally by intercalation.

Dimensions: Altitude 60 mm.; length 60 mm.; length of hinge 29 mm.; convexity of the two valves, 19 mm.

Type specimens: Of *hindsii* and *navarchus,* both of which are based on "*Pecten rubidus* Martyn" Hinds, in the British Museum (*fide* Carpenter); of *picoensis,* No. 31,419, of *venturaensis,* No. 31,416, at the University of California.

Type localities: Of *hindsii* and *navarchus,* Vancouver Island (*fide* Carpenter); of *picoensis* and *venturaensis,* upper Pico, Santa Barbara zone, uppermost Pliocene of Ventura Co., Calif.

Middle Pliocene: Pacific Beach, San Diego (Hamlin in Arnold).
Upper Pliocene: Type locality of *picoensis* and *venturaensis.*
Pleistocene: "Pliocene" of Deadman Island, San Pedro Harbor, Los Angeles Co., Calif. (Arnold); Vancouver and Sucia Islands, Puget Sound (Newcombe); Alaska (Dall, 1904).
Living: Bering Sea to San Diego (Dall).

This variety is very similar to typical *islandicus,* forming a link in the intergrading series between it and *P. hastatus.*

Some specimens are slightly spinose on the left valve and show a tendency to bunch the ribs into fascicles as in *P. hastatus,* but the majority of the specimens have rounded ribs covered with a microscopic network as in *Pecten beringianus.* Other specimens show a thinning out of the ribs as in the form *venturaensis*, approaching so closely the varieties *jordani* and *kincaidi* that it is doubtful whether the former of these, at least, should be separated even varietally. Waterfall did not recognize the variability of this variety nor the fact that the ribs tend to multiply in different ways on the two valves, else he would not have added two more names to the synonymy.

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[1] *Pecten marylandicus* Wagner, Journ. Acad. Nat. Sci., Phila., Vol. 8, p. 51, pl. 2, fig. 2, 1839.
Pecten tenuis Lea, Trans. Amer. Phil. Soc., Vol. 9, p. 246, pl. 35, fig. 33, 1845.
Pecten (*Chlamys*) *marylandicus* Wagner, Glenn, Maryland Geol. Survey, Miocene Volume, p. 376, pl. 99, fig. 6, 1904.

Pecten (Pecten) islandicus Müller variety **jordani** Arnold

Plate 11, Figure 4

Pecten (Chlamys) jordani Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 111, pl. 12, figs. 6, 7, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 114, pl. 44, figs. 1, 1*a*, 1*b*, 1906; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pecten jordani Arnold, McLaughlin and Waring, Folio accompanying Bull. 69, Calif. St. Mining Bureau, pl. 1, fig. 49, 1914.

Shell like that of the typical variety, with approximately the same shape, but smaller, the ribs less numerous and not multiplying so fast, those of the right valve much wider than the interspaces and not beginning to bifurcate until about 30 mm. long, those of the left rounded, rather distant, the intercalaries appearing at about the same time as the bifurcations on the right valve, both valves with a secondary sculpture of microscopic network.

Dimensions: Altitude, 37 mm.; length, 34 mm.; length of hinge line, 15 mm.; convexity of two valves, 11 mm.

Type specimen: No. 162,522 in the U. S. National Museum.

Type locality: "Pliocene" of Deadman Island, San Pedro Harbor, Los Angeles County.

U. Pliocene: Santa Barbara (Arnold); upper Pico, Santa Barbara zone, Ventura Co. (Waterfall).

Pleistocene: Type locality; also in the lower San Pedro series of the same locality (Arnold).

Living: At various localities with *hindsii*, not the specimen figured by Oldroyd (see *kincaidi*).

This variety is intermediate between *hindsii* and *kincaidi*, and it is doubtful whether any of the distinctions are of significance. It has fewer, simpler ribs than the typical *islandicus*, and is small; it has fewer, broader ribs, and is less elongate parallel to the hinge than *hindsii;* the ribs of *kincaidi* are narrower and do not bifurcate.

Pecten (Pecten) islandicus Müller variety **kincaidi** Oldroyd

Pecten kincaidi Oldroyd, Nautilus, Vol. 33, p. 135, pl. 4, figs. 3, 4, 1920.

Pecten (Chlamys) hindsii kincaidi Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 17, pl. 9, figs. 3, 4, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 53, pl. 12, figs. 1, 2, 1924.

Pecten (Chlamys) jordani Arnold, Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 19, pl. 2, figs. 1, 2, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 55, pl. 28, figs. 5, 6, 1924.

Shell like that of the variety *hindsii* but with fewer ribs, the ribs not multiplying, on the left valve faint intercalaries never rising to the height of the ribs.

Dimensions: Altitude, 40 mm.; length, 38 mm.; length of hinge line, 18 mm.; convexity of the two valves, 13 mm.

Type specimen: In the Oldroyd Collection at Stanford University.

Type locality: Puget Sound.

Living: In Puget Sound (and elsewhere with *hindsii ?*).

This variety is distinguished by its small size, and its few distant ribs.

Pecten (Pecten) opuntia Dall

Plate 11, Figure 3

Pecten (Chlamys) opuntia Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 707, pl. 29, fig. 6, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 113, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 118, pl. 41, fig. 2, 1906; Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 152, pl. 36, fig. 8, 1907; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 45, 1916; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 417, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 79, 80, 81, 82, 1929.

Shell of medium size, circular, not very convex, sides or anterior margins strongly incurving; sculpture of numerous (about 60) small, high, flat-topped ribs which show a tendency to increase in number, especially toward the free margins of the valves, by bifurcation and irregular intercalation, ribs marked on top by numerous small, thin, somewhat distant lamelliform imbrications; hinge line almost half as long as the shell, ears like those of *islandicus*.

Dimensions: Altitude, 52 mm.; length, 50 mm.; length of hinge, 23 mm.; convexity of the two valves, 16 mm.

Type specimen: No. 107,752 (and No. 7,938 ?) in the U. S. National Museum.

Type locality: Middle Pliocene of Pacific Beach, San Diego.

M. Pliocene: Type locality; Third Street tunnel, Los Angeles (Arnold); Temescal Canyon, Santa Monica Mountains (Arnold).

U. Pliocene: Rincon Creek, Santa Barbara Co. (Arnold); Packard's Hill, Santa Barbara (Arnold); Fourth and Broadway, Los Angeles (Moody); uppermost Pico of Ventura Co. (Waterfall).

? Pleistocene: Lower San Pedro formation, cold-water zone, of San Pedro (Stanford University collection).

This species, although probably related to *islandicus*, is quite constant in characters and is easily distinguishable. It is most like the living *P. patagonicus* King, from the Straits of Magellan. Although not common, it is useful in California as an index to the upper half of the Pliocene. The lower Pleistocene record, based on the Stanford University collection, is very unreliable. Waterfall has made considerable use of it in his recent work of correlation in Ventura County.

Pecten (Pecten) lioicus Dall

Pecten (Chlamys) lioicus Dall, Amer. Jour. Sci., Ser. 4, Vol. 23, p. 457, text figure on p. 458, 1907; Dall in Moffit, Bull. 533 U. S. Geol. Survey, p. 46, 1913; Dall, Prof. Paper 125-C U. S. Geol. Survey, p. 31, 1920.

Shell like that of *islandicus* in shape, but almost smooth.

Dimensions: Altitude, 61 mm.; length, 55 mm.; length of hinge, 30 mm.

Type specimen: No. 110,480 in the U. S. National Museum.

Type locality: "Fifty feet below the surface in marine gravels near Nome, Norton Sound, Alaska,"—Otter Creek ?

Pliocene: Type locality.

Dall states in 1920 that "no further specimens of this very distinct species have come to hand." Perhaps the original specimen is but a monstrosity of *islandicus*. It looks somewhat like living forms of *P. squamosus* (Gmelin) from Japan upon which the ribs are nearly obsolete; but it has a shorter byssal ear, shallower byssal notch, and straighter anterior margins.

Pecten (Pecten) beringianus Middendorff

Plate 11, Figure 2

Pecten islandicus var. *beringianus* Middendorff, "Beitr. Malac. Ross.", Mém. Acad. Imper. Sci., St.-Pétersbourg, Ser. 6, Vol. 6, Pt. 3, p. 12, 1849; Dall, Nautilus, Vol. 27, p. 122, 1914; Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919.

Pecten (Chlamys) hericeus Gould var. *strategus* Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 709, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 110, pl. 11, fig. 5, 1903.

Pecten (*Chlamys*) *hastatus* Sowerby var. *strategus* Dall, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 113, pl. 44, figs. 2, 2*a*, 3, 4, 1906; Proc. U. S. Nat. Mus., Vol. 32, p. 545, pl. 50, fig. 13, 1907, figure reproduced in Bull. 309 U. S. Geol. Survey, pl. 40, fig. 13, 1907.

Pecten (*Chlamys*) *islandicus beringianus* Middendorff, Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 55, pl. 41, figs. 1, 2, 1927.

Shell of medium or small size, shorter than deep, characterized by about seven large swollen ribs on each valve when young, the number increasing rapidly after reaching an altitude of about 20 mm., increasing on the right valve by bifurcation, on the left by intercalation, both valves covered with a microscopic network like that on *P. islandicus* variety *jordani;* ears like those of *jordani.*

Dimensions: Altitude, 35 mm.; length, 34 mm.; length of hinge, 17 mm.; convexity of the two valves, 16 mm.

Type specimens: Of *beringianus,* in Acad. St. Petersburg (*fide* Oldroyd); of *strategus,* in the U. S. National Museum (?).

Type localities: Of *beringianus,* Bering Sea; of *strategus,* Unalaska.

Upper Pliocene: Santa Barbara (Arnold); uppermost Pico of loc. 218 S. D. S. N. H., Sulphur Canyon, east of South Mt., Ventura Co., two specimens (H. R. G.).

Pleistocene: Alaska (Dall); lower San Pedro series of Deadman Island, San Pedro Harbor, Los Angeles Co. (Arnold).

Living: Bering Sea (Middendorff; Dall).

This species is easily distinguished by the few broad swollen ribs on the early part. Most of the specimens figured are immature or stunted. It may be, as Middendorff thought, a variety of *islandicus,* for it is very like the form *jordani.* In some respects it is closer to *hastatus,* but it lacks the spines and is covered with a peculiar cross-hatching.

The occurrence of this cold-water species in the uppermost Pliocene and the lower Pleistocene of southern California is very significant.

Pecten (Pecten) hastatus Sowerby

Plate 11, Figures 6*a*, 6*b*

Pecten hastatus Sowerby, Thes. Conch., Vol. 1, p. 72, pl. 20, fig. 236, 1843; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 11, species 43, 1852; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 528, 532, 645, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 104, 1868-9; Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 297, 1874; Whiteaves, Trans. Royal Soc. Canada, Vol. 4, p. 119, 1887; Küster and Kobelt, Syst. Conch. Cab., N. S., Vol. 17, Pt. 2, spec. 210, p. 233, pl. 62, figs. 1, 2, 1888; Cooper, Seventh Ann. Rept. Calif. St. Mineralogist, p. 257, 1888; Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 708, 1898; Keep, West Amer. Shells, p. 40, 1904; Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 301, 302, 1917; Kew, Bull. 753 U. S. Geol. Survey, pp. 78, 88, 1924.

Pecten rastellinum Valenciennes, Voy. Venus, pl. 19, fig. 4, 1846 (*fide* Carpenter).

Pecten hericius Gould, Proc. Bost. Soc. Nat. Hist., Vol. 3, p. 345, 1850; U. S. Exploring Exped. (Wilkes), Vol. 12, p. 457, 1852, Mollusca Atlas, pl. 42, 1856; Keep, West Amer. Shells, pp. 39-40, fig. 19, 1904.

Pecten altiplectus (typ. err.) Conrad, Proc. Acad. Nat. Sci., Phila., Ser. 1, Vol. 8, p. 313, (1856) 1857.

Pecten altiplicatus Conrad, U. S. Pacific R. R. Survey, Vol. 7, p. 191, pl. 3, fig. 2, 1857.

Pecten (*Chlamys*) *altiplicatus* Conrad, Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 700, 1898.

Pecten (*Chlamys*) *hericeus* Gould, Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 708, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 110, pl. 11, fig. 2, 1903.

Pecten (*Chlamys*) *hericius* Gould, Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 45, 1916; Dall, Bull. 112 U. S. Nat. Mus., p. 18, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 16, pl. 23, figs. 1, 2, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 52, pl. 7, figs. 1, 2, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pecten (*Chlamys*) *hastatus* Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 109, pl. 11, figs. 4, 4*a*, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 108, pl. 41, fig. 4, pl. 42, figs. 1, 1*a*, 2, 2*a*, 1906; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 45, 1916; Dall, Bull. 112 U. S. Nat. Mus., p. 18, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 53, pl. 29, figs. 1, 3, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pecten (*Chlamys*) *hastatus* Sowerby var. *heric us* Gould, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 110, pl. 43, figs. 3, 3*a*, 1906.

Pecten (*Chlamys*) *lawsoni* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 117, pl. 45, figs. 3, 4, 1906.

Pecten hastatus var. *hericius* Gould, Kew, Bul . 753 U. S. Geol. Survey, pp. 78, 88, 1924.

Shell of moderate size, triangularly ovate, higher than long, anterior margins or sides incurving, valves moderately convex; sculptured with strong, distant, spinose ribs, each rib with one or two somewhat less prickly minor striations on each side, ribs of the right valve about twenty in number, paired, with sometimes very minor intercalaries or minor striations between, ribs of left valve strong, high, sometimes with long spines, primary ones ten in number, with ten main intercalaries and a number of lesser ones; hinge line less than half as long as the shell, ventral ears more than twice as long as the dorsal, byssal ear somewhat obliquely terminated, sculptured with about five riblets with intercalaries, byssal scar wide, notch deep, other ears with numerous fine riblets.

Dimensions: Altitude, 70 mm.; length, 65 mm.; length of hinge, 31 mm.; convexity of two valves, 21 mm.,—a large specimen.

Type specimens: Of *hastatus,* in London, Cuming Collection (*fide* Oldroyd); of *hericius,* in the collection of the Boston Society of Natural History; of *altiplicatus,* No. 13,350 in the U. S. National Museum (figured by Arnold, 1906); of *lawsoni,* probably destroyed by the San Francisco earthquake.

Type localities: Of *hastatus,* unknown; of *hericius,* Strait of Juan de Fuca, Puget Sound; of *altiplicatus,* Pliocene of the San Raphael Hills, Santa Barbara Co.; of *lawsoni,* Pliocene of the Waldorf Asphalt Mine, four miles south of Guadaloupe, Santa Barbara County, California.

U. Miocene: San Lucas, Monterey Co., a variety ? (Arnold); Santa Margarita formation of the Coalinga district (Arnold; Nomland); of the Tejon Hills at the southern end of the San Joaquin basin (Nomland).

Pliocene: Type localities of *altiplicatus* and *lawsoni;* San Diego (Dall, 1874); Santa Monica Mountains (Rivers in Arnold); Pico and supposed "Saugus" of Los Angeles Co. (Kew); Santa Barbara (Arnold); upper Pico, Santa Barbara horizon, of Ventura Co. (Waterfall); loc. 218 S. D. S. N. H., Sulphur Canyon east of South Mt., Ventura Co., two specimens (H. R. G.).

Pleistocene: "Pliocene" of Deadman Island, San Pedro Harbor (Arnold); lower San Pedro of San Pedro (Arnold); "Saugus" of Ventura Co. (Kew).

Living: Alaska to San Diego (Dall).

Pacific coast conchologists have long tried to separate *hastatus* Sowerby from *hericius* Gould, though Carpenter had already pointed out that they are the same. The former is nothing but the slightly deeper water southern variation of the form commonly called *hericius,* and can be told only by slightly longer spines on the left valve and by slightly smaller size, these differences not being significant in a classificatory sense. Small specimens of *hericius* cannot as a rule be distinguished from *hastatus.* Dall and Arnold recognized the synonymy of *altiplicatus;* and *lawsoni* is the same, badly worn so that it is almost unrecognizable.

This species is distinguishable from *islandicus* by its smaller size, by its more curving sides, by its deeper, broader byssal notch, and by its more differentiated ribs, the ribs being formed by gathering together the lesser riblets of *islandicus* into fascicles, the center riblet of which is the most elevated. Nevertheless, it is very clear that this species is closely related to *islandicus,* being connected with it by intergarding series. Carpenter noted one series in describing *hindsii,* the ribs of which sometimes tend to form spinose, triangular-shaped fascicles as in *hastatus,* especially on the left valve; and this series is made more complete by the variety *albidus* of *hastatus.* Middendorff noted another series of intergradations in describing *beringianus,* which he assigned as a variety to *islandicus,* and indeed *beringianus* is just one step beyond *jordani* in an unbroken series of variations, having the rounded ribs, the minor sculpture and the form of the byssal notch as in *jordani,* but the size and shape and arrangement of the ribs as in *hastatus* so that it has more frequently been assigned to *hastatus* as a variety. These relationships are none the less important because the writers now consider *beringianus* a full species, the three species forming a triangular intergrading group. In addition, *P. hastatus* is closely related to the *P. varius* group through *sancti-ludovici*, having the same narrow shape when young, broadening in the adult, the same long byssal ear, and the spinose ribs; and it is practically certain that the two converge in the Miocene. *P. sancti-ludovici* is more like *islandicus* in the character of the ribs. Another species, which has departed still more from the *islandicus* type but which is likewise almost certainly of the same immediate derivation as *hastatus*, is the sessile *multirugosus*, often separated, as the writers believe erroneously, into a distinct genus *Hinnites*.

Pecten (Pecten) hastatus Sowerby variety **albidus** Dall in Arnold

Pecten (*Chlamys*) *hastatus* Sowerby var. *albidus* Dall, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 136, pl. 52, figs. 2, 2*a*, 1906.

Pecten (*hericius* Gould var. ?) *albidus* Dall, Bull. 112 U. S. Nat. Mus., p. 18, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 52, pl. 12, figs. 8, 9, 1924.

Shell like that of the typical variety, but with the ribs not so strongly gathered into fascicles, less spinose, the byssal ear more like that of *islandicus*.

Dimensions: Altitude, 45 mm.; length, 40 mm.; length of hinge line, 19 mm.; convexity of the two valves, 14 mm.

Type specimen: No. 150,207 in the U. S. National Museum.

Type locality: Unalaska.

Living: Bering Sea.

It is possible that this form should be assigned to *islandicus* instead of *hastatus*.

Pecten (Pecten) hastatus Sowerby variety **pugetensis** Oldroyd

Pecten islandicus pugetensis Oldroyd, Nautilus, Vol. 33, p. 136, pl. 4, figs. 5, 6, 1920.

Pecten (*Chlamys*) *islandicus pugetensis* Oldroyd, Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 18, pl. 9, figs. 5, 6, 1924; Stanford Univ. Publ. Geol. Vol. 1, p. 55, pl. 12, figs. 4, 5, 1924.

Shell like that of the typical variety, but smaller and more convex.

Dimensions: Altitude, 33 mm.; length, 30 mm.; length of hinge line, 18 mm.; convexity of the two valves, 17 mm.

Type specimen: In the Oldroyd Collection at Stanford University.

Type locality: San Juan Island, Puget Sound.

? M. Pliocene: Loc. 228, S. D. S. N. H., southeast of Pico Canyon, Los Angeles Co., one broken specimen (H. R. G.).

Living: Puget Sound.

This form clearly belongs with *hastatus* rather than *islandicus*, being barely distinguishable from the former. Young specimens of the typical variety have relatively longer ears also.

Pecten (Pecten) bartschi Arnold

Pecten (*Chlamys*) *bartschi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 107, pl. 41, fig. 3, 1906.

? *Pecten sancti-ludovici* Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 55, pl. 3, figs. 10*a*, 10*b*, 1914; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 304, 1917; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 473, pl. 22, figs. 1, 2, 3, 1924.

? *Pecten egregius* Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 231, pl. 6, figs. 3, 3*a*, 3*b*, 1917, young.

? *Pecten* (*Chlamys*) *hodgei* Hertlein, Bull. So. Calif. Acad. Sci., Vol. 24, p. 42, pl. 4, figs. 1, 2, 1925.

Shell of medium size, with the shape and general characters of *hastatus* except that the byssal ear is somewhat longer and the primary ribs do not have the paired arrangement (if paired, it is because the primary ribs have split, and the ribs are twice as numerous), the primary ribs varying from 20 to 25 in number, with sometimes prominent intercalaries appearing irregularly and increasing the number considerably, secondary riblets on the sides of the primaries sometimes developed, especially in the fewer ribbed varieties, main ribs each with a single row of short, stout prickles.

Dimensions: Altitude, 50 mm.; length, 45 mm.; length of hinge, 27.5 mm.; convexity of the two valves, 23 mm.

Type specimens: Of *bartschi*, No. 164,841 in the U. S. National Museum; of *sancti-ludovici*, No. 107 in the California Academy of Sciences; of *egregius*, No. 11,090 at the University of California; of *hodgei*, No. 20 at Stanford University.

Type localities: Of *bartschi*, "lower Pliocene," Crescent City, Del Norte Co., northern California; of *sancti-ludovici*, Santa Margarita formation on the west side of the San Juan River about a half mile above the mouth of Navajoa Creek, northeastern San Luis Obispo Co.; of *egregius*, Etchegoin, middle Pliocene of the Coalinga district, middle California; of *hodgei*, Santa Margarita formation of the Coalinga region.

? U. Miocene: Type localities of *sancti-ludovici* and *hodgei;* Nacimiento River, San Luis Obispo Co. (Nomland, as *sancti-ludovici*).

? Pliocene: Type localities of *bartschi* and *egregius;* Pliocene of Coyote Mountain, Imperial Co. (Hanna, as *sancti-ludovici*).

There is great uncertainty about this species and its possible synonyms. Arnold's type is so poor that practically nothing can be done with it. The ribs and spines are coarser than those of *opuntia*, and it is unlikely that it is closely related to *opuntia*. The type of *sancti-ludovici* is so like *hastatus* that it should perhaps be included with that species as a variety. On the other hand, there are specimens from the upper Miocene of San Luis Obispo Co. in the collection at Stanford University that are practically indistinguishable from some living specimens of *P. varius* (Linnæus) from Europe. These Stanford Miocene specimens have more numerous, simpler ribs than the type of *sancti-ludovici*. A small one, like the young of *varius*, shows the characters of *egregius*. The type of *hodgei* is like *sancti-ludovici* except that each of the primary ribs splits near the apex, thus making the number of ribs more like that of typical *bartschi*. Hertlein compares his species to *P. halimensis* Makiyama[1] from the Pliocene of Japan.

Typical *bartschi* is a large form on which the intercalaries are well developed, making the ribbing quite complex. It is possible that the other forms should be separated as varieties, or even that *bartschi* should be referred to *islandicus*. The paratypes of *hodgei* have more numerous, finer ribs and are more like *P. tenuigranosus* Reeve from the west coast of Panama (Conch. Icon., Vol. 8, *Pecten*, pl. 35, species 176, 1853).

Pecten (Pecten) dallasi Jordan and Hertlein

Pecten (*Chlamys*) *dallasi* Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 213, pl. 23, figs. 2, 5, 6, 8, 1926.

Shell of medium size, practically circular, not very convex; sculptured with 15 to 19 rounded ribs, somewhat flattened on top, about equal in width to the interspaces, both ribs and interspaces covered with numerous, fairly strong striations (not very well shown in the original figure); hinge line about half as long as the shell, ears shallow, byssal notch narrow, not very deep, ventral ears half again as long as the dorsal, byssal ear with five or six rather strong riblets, other ears with three or four distant riblets and minor striations.

Dimensions: Altitude, 46 mm.; length, 46 mm.; length of hinge, 23 mm.; convexity of the two valves, 14 mm.

Type specimen: No. 1,862 at the California Academy of Sciences.

Type locality: Pliocene near San Antonio Point, eastern Lower California.

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[1] *Pecten halimensis* Makiyama, Japanese Jour. Geol. Geog., Vol. 2, p. 23, pl. 4, fig. 1, 1923.

Pliocene: Type locality; also of Maria Madre Island, Mexico; possibly also at Coyote Mt., Imperial Co., Calif., as *P. sancti-ludovici.*

This species resembles somewhat *P. islandicus* var. *kincaidi*, and *P. sancti-ludovici*, but is distinguished by greater length, shallower ears, shallower byssal notch, and regular ribs with superimposed striations. It approaches closely the typical form of *Aequipecten*, and should, perhaps, be assigned to that subgenus.

Subgenus **PALLIUM** Schumacher, 1817

Pallium Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 120, 1817; Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 696. 1898.

Type (by monotypy), *Pallium striatum* Schumacher, *op. cit.*, p. 120, pl. 4, fig. 4, = *Pecten plicatus* Chemnitz, Neues Syst. Conch. Cab., Vol. 7, p. 292, pl. 62, figs. 598 *a, b*, 1784, = *Ostrea plica* Linnæus, living, Japan.

Shell like that of the free forms of typical *Pecten*, i. e., *Chlamys*, but with several, more or less prominent, rounded radial folds (typically three to seven, though sometimes the number is increased to ten or more by the intercalation of secondaries or by the splitting of the major folds), upon which are superimposed the numerous fine radial ribs of *Chlamys;* shell tending to contract around the basal margin after becoming mature and sometimes at other stages of growth, with the result that the free ends of the valves sometimes meet each other nearly perpendicularly; shell triangular, usually with a relatively great altitude and short hinge line.

Geologic range: Tertiary and Recent.

Distribution: Warm waters, mainly Oriental.

This subgenus is connected very closely with *Pecten, s. s.*, section *Chlamys*, and with *Lyropecten* through the section *Manupecten;* and indeed, it might be well to reduce it to a section of *Pecten* of equal value with *Manupecten*, the latter being a more normal form, whereas typical *Pallium* appears to be a specialized derivative. The distribution of this group is mainly Oriental, but at various times individual species have wandered into other parts of the world. According to Dall, the development of the cardinal grooves on the inside of the hinge (stressed so much by Schumacher and others) is a function of the short hinge line and is in itself of little systematic importance. Similar grooves were developed in *Lyropecten* because the heavy valves required a more efficient articulation.

Section Pallium, s. s.

Shell with a short hinge line, with small, nearly square, nearly equal ears; altitude of the shell relatively great.

Some of the species included in the typical section are: *P. plicus* (Linnæus), Japan; *P. subplicatus* Sowerby, East Indies; *P. amiculus* Philippi, Japan; *P. distans* Lamarck, Philippines; *P. flabelloides* Reeve, Ceylon; and *P. radula* (Linnæus), China. *P. pallium* (Linnæus) appears to be more closely allied to typical *Pecten.* The distribution of the group appears to be entirely Oriental. There are no species in North America.

Section Manupecten Monterosato, 1872

Manupecten Monterosato, Notizie Conch. Medit., p. 17, 1872.

Felipes Locard, Sacco, Boll. Mus. Zool. ed Anat. Comp., R. Univ. Torino (Turin), Vol. 12, p. 101, June 11, 1897; ? I. Molluschi dei Terrani Terziarii del Piemonte e della Liguria, Pt. 24, 1897; type, *pesfelis* Linnæus (*fide* Verrill and Bush, Proc. U. S. Nat. Mus., Vol. 20, p. 833, 1898).

Type (by monotypy ?), *Ostrea pesfelis* Linnæus, Recent, Corsica, illustrated by Sowerby, Thes. Conch., Vol. 1, p. 67, pl. 17, fig. 162, pl. 20, fig. 234, 1842, and by Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 19, species 66, 1853.

Shell like that of typical *Pallium* except that the ears are very unequal, varying from the form of the ears of typical *Pecten*, in which the byssal ear is rounded on the end, to that of *P. pesfelis*, in which all the ears are trigonal in shape, the ventral ones large, with an undifferentiated byssal notch, the dorsal ones very small.

Geologic range: Miocene to Pliocene (California); Pliocene or Pleistocene of Alaska; Pliocene to Recent in the Orient.

Distribution: Warm and temperate waters of the Old World.

This section is of doubtful value, but forms the link between *Pallium* and *Chlamys*, and seems to have a geographic as well as a morphologic distinction. It inhabits cooler water than typical *Pallium*, being intermediate in this respect also between *Chlamys* and *Pallium*, and is found in parts of the world other than the Orient. Besides the type and *P. swiftii* with its relatives, the following species should probably be included: *P. tigris* Lamarck, Philippines; *P. sanguinolenta* (Gmelin), Red Sea.

Pecten (Pallium) hamlini Arnold

Pecten (Chlamys) hamlini Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 67, pl. 11, fig. 2, 1906.

Type specimen: No. 164,844 in the U. S. National Museum.

Type locality: Near head of Slack's Canyon, Mount Diablo Range, Monterey Co.

? Middle Miocene: Type locality, and also near Stanford University, Santa Clara Co.

The original specimen of this species is very poor and badly distorted. Specimens in the collection at Stanford University show that it is a form of the *P. swiftii* type, distinguishable from the variety *parmeleei* of that species not by its shape but by its fewer, coarser secondary ribs.

Pecten (Pallium) swiftii Bernardi

Plate 10, Figures 1*a*, 1*b*, 2, 4*a*, 4*b*, 5

Pecten swiftii Bernardi, Journ. de Conchyl., Vol. 7, p. 90, pl. 1, fig. 1, pl. 2, fig. 1, 1858; Schrenck, Mollusken des Amur-Landes und des Nordjapanischen Meeres, p. 487, pl. 21, figs. 1, 2, 3, St. Petersberg, 1867; Dunker, Index Molluscorum Maris Japonici, p. 242, 1882; Hirase, Cat. Mar. Jap. Sh., p. 33, pl. 3, fig. 15, 1907; Dall, Prof. Paper 125-C U. S. Geol. Survey, p. 31, 1920; Yokoyama, "Foss. Miura Penin." Journ. Coll. Sci., Imper. Univ. Tokyo, Vol. 39, p. 154, pl. 14, fig. 11, 1920; "Moll. Rem. Up. Pt. Jô-Ban Coal-field," Journ. Coll. Sci., Imper. Univ. Tokyo, Vol. 45, p. 27, pl. 2, fig. 7, 1925; "Moll. Tert. Basin Chichibu," Journ. Fac. Sci., Imper. Univ. Tokyo, Vol. 1, p. 123, pl. 15, fig. 3, 1925; "Tert. Moll. Shiobara," Journ. Fac. Sci., Imper. Univ. Tokyo, Vol. 1, p. 135, 1926; "Tert. Moll. Oilfields of Embets and Etaibets," Journ. Fac. Sci. Imper. Univ. Tokyo, Vol. 1, p. 245, 1926; "Fos. Sh. from Sado," Journ. Fac. Sci., Imper. Univ. Tokyo, Vol. 1 p. 303, pl. 37, figs. 5, 6, 1926.

Pecten (Chlamys) parmeleei Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 708, pl. 37, figs. 14, 14*a*, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 119, pl. 41, figs. 1, 1*a*, 5, 5*a*, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 25, pl. 36, fig. 7 (Dall's figure again reproduced), 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907.

Shell large, elongate, subtriangular in shape; body of the shell ornamented with a few large, more or less prominent folds and small superimposed ribs or striations; the whole surface including the ears covered with a fine sculptural network or cross-hatching; free ends of the valves often contracted as is characteristic of the subgenus, in many specimens other constrictions at earlier stages of growth giving the main ribs or folds a nodose appearance, superimposed striations worn off when the nodes or ribs are high; hinge line short, sometimes oblique to the axis of the shell; ears varying greatly in size and shape, the byssal notch sometimes moderately deep and the end of the ear arcuate, sometimes almost lacking, with the end of the ear extending obliquely outwards to a point; ears in most specimens very unequal, radially striate, on large shells with five to nine coarse striations, sometimes alternating in size, coarser on the outer edge.

Dimensions: Altitude, 105 mm.; longitude, 90 mm.; length of hinge, 50 mm.; convexity of two valves, 35 mm.

Type specimen: Of *parmeleei*, No. 154,479 in the U. S. National Museum.

Type localities: Of *swiftii*, living in Japan; of *parmeleei*, Pliocene of San Diego.

Pliocene: San Diego (as *parmeleei*, Dall); Crescent City, Del Norte Co. (Arnold; Dall); middle Pico of locality 217*a*, Holser Canyon, Los Angeles Co., one small, stunted specimen, very well preserved and closer to the typical variety than to any other variety yet described (H. R. G.); Pliocene of various localities in Japan (Yokoyama).

Pleistocene: Of northern Japan (Yokoyama).

Living: Northern Japan, Sea of Okhotsk, Alaska (Yokoyama).

"There is a great deal of variation in the form of the ribs which in some specimens are high and prominent, while in others they are low and flattened. Their number, however, is tolerably constant, the main ribs being generally four in the right valve and five in the left. The outline is very characteristic, and the height is invariably greater than the length" (Yokoyama). The number and coarseness of the striations on the major ribs and interspaces, the size, ventricosity, and amount of elongation of the shell are all very variable. The typical form is characterized by moderately high relief, large size, and large ventral ears.

Pecten parmeleei Dall, 1898, is the first representative of *Pecten swiftii* to be described from the Pacific coast of North America. Dall said: "This species is close to *P. swiftii* Bernardi of Japan but smaller, and differs by the smooth top surface of the ribs, which in *P. swiftii* are more or less striated or coarsely threaded, and by the not alternated radial riblets on the right posterior ear; also, especially, by the profuse coalescent microscopically checkered squamation which makes a complete external coating of the valve."

An examination of a series of living shells from Japan shows that none of these criteria is sufficient to separate Dall's species from the living. It is true that Dall's type specimen is only half as large, but the constrictions on it show that it is less than half as old. The early part of the left valve of Bernardi's type is almost exactly like Dall's type, as shown by the figures. Dall admits that the specimen from the Pliocene of Crescent City, California, figured by Arnold (1906) as *parmeleei* is indistinguishable from *swiftii*. The California fossil specimens assignable to the typical variety of *swiftii* have so far not been very common, which probably accounts for the fact that none have been found so large as the Japanese living specimens selected for collections. Arnold's specimen measures only 70 mm. Dall meant to say in his description the left posterior (or as Arnold has it the left anterior) ear, for the only valve Dall had was a left valve. The dorsal (= posterior) ears are often very poorly developed and in fossils are usually broken off, but when sufficiently developed show radiating ridges as well as the ventral ears; and even in the living specimens of *swiftii* the ridges on the ears are not always alternating in size. Both the living and fossil forms show striations on the main ribs or folds of the body of the shell if the surface has not been worn; but if worn, neither does. The "checkered squamation" or microscopic network is very evident on the living Japanese shells and is of the same character as that on the California Pliocene forms.

Pecten (Pallium) swiftii Bernardi variety **etchegoini** Anderson

Plate 10, Figures 3*a*, 3*b*

Pecten etchegoini Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 2, p. 198, pl. 18, figs. 92, 93, 1905; Nomland Univ. Calif. Publ. Geol., Vol. 10, p. 219, pl. 7, figs. 1, 1*a*, 1*b*, pl., 8, figs. 2, 2*a*, etc. 1917.

Pecten (*Chlamys*) *wattsi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 120, pl. 11, figs. 1, 1*a*, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pl. 35, fig. 1 (same figure), 1907; Arnold and R. Anderson, Bull. 322 U. S. Geol. Survey, p. 59, pl. 25, fig. 4 (same figure), 1907; Arnold, Bull. 396, p. 77, pl. 27, figs. 1, 2, Jan. 15 1910; Arnold and R. Anderson, Bull. 398, pp. 119, 126, 129, 132, 137, pl. 49, figs. 1, 2 (same figures), 1910.

Pecten (*Chlamys*) *wattsi* var. *morani* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 121, pl. 10, figs. 3, 4, 5, 6, 1906.

Pecten (*Chlamys*) *wattsi* var. *etchegoini* Anderson, Arnold, Bull. 396 U. S. Geol. Survey, p. 77, Jan. 15, 1910; Arnold and R. Anderson, Bull. 398, pp. 129, 137, 1910; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

Pecten wattsi Arnold, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

Pecten etchegoini var. *wattsi* Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 219, pl. 7, eight figures, pl. 8, figs. 2, 2*a*, 2*b*, 1917.

"*Pecten tigerrinus* Müller," Yokoyama, "Foss. Miura Penin.", Journ. Coll. Sci., Imper. Univ. Tokyo, Vol. 39, p. 155, pl. 14, figs. 5, 6, 1920, not *P. tigrinus* Müller.

Pecten cosibensis Yokoyama, Journ. Geol. Soc. Tokyo, Vol. 18 (No. 208), p. 4, pl. 1, figs. 3, 4, Jan. 20, 1911; "Foss. Miura Penin.", Journ. Coll. Sci.. Imper. Univ. Tokyo, Vol. 39, p. 156, pl. 13, figs. 7, 8, 1920; "Foss. Shells from Sado, Journ. Fac. Sci.," Imper. Univ. Tokyo, Vol. 1, p. 304, pl. 53, figs. 7, 8, 1926.

The variety *etchegoini* (including the forms *wattsi* and *cosibensis*) is recorded from the following localities:

? Miocene: A specimen in the Stanford collection labelled *P. hamlini* Arnold looks very much like this variety and probably belongs here. It is said to have come from Burial Hill, Los Altos, California.

Pliocene: Etchegoin formation of Coalinga (Anderson; Arnold), common in the *Pecten coalingensis* zone and rare in the *Mya japonica* zone but not found below (Nomland); Pescadero Creek, one-fourth mile above Jones Gulch, San Mateo Co. (Arnold); Kreyenhagen's Ranch, Fresno Co. (Watts; Arnold); Olinda, Puente Hills, Orange Co. (Eldridge and Arnold; English); middle Pico of locality 217, one specimen, and 217*a*, two specimens, one of the latter with constrictions as in the form *wattsi*, Holser Canyon, Los Angeles Co. (H. R. G.); middle Pico of locality 228, southeast of Pico Canyon, Los Angeles Co., one very small specimen with constrictions (H. R. G.); northern Japan—Sawané, rare (Yokoyama).

Pecten etchegoini may be distinguishable from *swiftii* as a variety. It is characterized by coarser striations on the folds and by its generally somewhat stunted form. It is itself very variable, some specimens being relatively much more elongate than the typical *swiftii* and others much less, some forms lacking the concentric constrictions, whereas on others the constrictions may be abnormally strong. In view of the wide variations in the living variety, it seems of little use to try to separate these forms, some of which are still unnamed, especially as they all occur together and seem to have no significance. Arnold described two of them in 1906, as *wattsi* and *wattsi* var. *morani*, afterwards recognizing that the latter is exactly the same as *etchegoini*. *Wattsi* is the form with the abnormally strong constrictions. Arnold also described in 1906 the variety *nutteri* which has more irregular ribs, the major folds on the right valve dividing in the middle so that they no longer stand out clearly as individuals, and intercalaries appearing on the left valve about equal in size to the main ribs. Nomland (1917) has shown by a series of figures (and specimens and figures of other authors confirm his conclusion) that all these forms intergrade. It is the writers' belief that we have to deal here with a single very variable species, on the variations of which almost every possible combination of the many variable specific characters is known. Arnold (1910) distinguished *wattsi* from *etchegoini* entirely on the basis of stronger concentric constrictions, though the strength of the constrictions is an individual characteristic dependent upon seasonal changes in temperature or some other environmental factor. The Japanese have recognized in their Pliocene all of these variations and have given them names just as we have, though they do not attempt to state the distinctions between their varities and the typical form, which they also recognize. The form *nutteri* is here separated as a variety, for its relations with the Miocene species may have some significance.

Pecten (Pallium) swiftii Bernardi variety **nutteri** Arnold

Pecten (Chlamys) nutteri Arnold, Prof. Paper 47, U. S. Geol. Survey, p. 67, pl. 11, figs. 3, 4, 4*a*, 1906; Bull. 396 U. S. Geol. Survey, pp. 31, 35, 39, pl. 27, figs. 3, 4, 1909; Arnold and Anderson, Bull 398, p. 129, pl. 49, figs. 3, 4 (same figures), 1910.

Pecten nutteri Arnold, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

Pecten etchegoini var. *nutteri* Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 219, pl. 7, figs. 4, 5, pl. 8, figs. 2*a*, 2*b*, 1917.

Pecten heteroglyptus Yokoyama, Journ. Fac. Sci., Imper. Univ. Tokyo, Vol. I, p. 304, pl. 33, figs. 1-6, 1926.

Type specimen: No. 6 in the type collection at Stanford University.

Type locality: Lower Pliocene near San Gregorio, San Mateo Co., Calif.

Pliocene: New Brighton Beach, Santa Cruz Co. (Humphreys); Mt. Hamilton, Santa Clara Co., — Miocene or Pliocene ? (Arnold); Kreyenhagen's Ranch, Fresno Co. (Watts; Arnold); Purisima to Pescadero, San Mateo Co. (J. P. Smith; Arnold; etc.); Coalinga (Arnold); common in the *Pecten coalingensis* zone, not reported from the other zones (Nomland); northern Japan, uppermost Pliocene (Lower Musashino) of Sado Island; also from Kaidaté, common, and from the upper horizon at Sawané, rare (Yokoyama).

This variety is characterized by the splitting of the main ribs of the right valve and the development of strong intercalaries on the left valve so that the number of ribs is doubled, or more than doubled, and the shell has an appearance as if it were sculptured by a considerable number of ribs of irregular size, shape, and spacing. A specimen in the the collection at Stanford University from the lower Pliocene of Santa Cruz Co., has an altitude of 85 mm.

This variety is not reported from the Pleistocene or Recent, but is represented in older formations by several related forms. It is possible that the other varieties have been derived from this one.

Pecten (Pallium) swiftii Bernardi variety **kindlei** Dall

Plate 10, Figure 7

Pecten (Chlamys) swiftii Bernardi, Dall, Amer. Jour. Sci., Vol. 173, p. 457, 1907.

Pecten (Chlamys) kindlei Dall, Prof. Paper 125 U. S. Geol. Survey, p. 30, pl. 6, figs. 2, 7, 1920.

This variety is characterized by large size, low surface relief, and low ventricosity. It is found only as a fossil in beds of probable Pleistocene age in Alaska.

Section Peplum Bucquoy, Dautzenberg, and Dollfus, 1889

Peplum Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 67, 1889.

Flexopecten Sacco, I Molluschi dei terreni terziarii del Piemonte e della Liguria, Pt. 24, p. 38, Turin, 1897, type *P. flexuosus* (Poli).

Type (by original designation), *Ostrea clavata* Poli, Recent, distributed from northern Scotland to the Mediterranean; described and illustrated by Sowerby, Thes. Conch., Vol. 1, p. 60, pl. 12, figs. 14, 15, 1842, by Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 4, species 18, 1852, and by B., D., and D., *op. cit.*, p. 68, pl. 16, figs. 10-17, 1889.

Shell like that of typical *Pallium* but small, thin, more circular in shape, the radial striation sometimes weak.

Geologic range: Pliocene (possibly Miocene) to Recent (B., D., D.).

Distribution: East Atlantic and Mediterranean, Indian Ocean.

On some of the thin-shelled, possibly degenerate species of this section, the radial striation is almost obsolete. The relation to *Pallium, s. s.*, is shown by the radiating folds, by the nearly equal ears, and in some individuals by the characteristic contraction of the free margins of the shells. In *Peplum*, including *P. septemradiatus* Müller from Scotland, as well as the type, the ears are short and square as in *Pallium, s. s.;* but in *Flexopecten*, including *P. flexuosus* (Poli), Mediterranean, *P. glaber* (Linnæus), Mediterranean, and probably *P. parvus* Reeve, Mauritius, the ears are somewhat longer and pointed. Probably *Flexopecten* should be recognized as a section also, having perhaps as much or as little value as *Manupecten*. This section is included here, although not found in North America, to illustrate the multifarity of form that a group of related Pectens may assume.

Subgenus **LYROPECTEN** Conrad, 1862

Lyropecten Conrad, Proc. Acad. Nat. Sci., Phila., p. 291, 1862, species in the original list are *Pallium estrellanum* Conrad, U. S. Pacific R. R. Survey, Reports, Vol. 6, p. 71, pl. 3, fig. 15, 1857, *Lyropecten volæformis* Conrad, new name for *Pallium estrellanum* Conrad, U. S. Pacific R. R. Survey, Reports, Vol. 7, p. 191, pl. 3, figs. 3, 4, 1857, and *Lyropecten crassicardo* Conrad, described as if new, *loc. cit.*, but probably the same as the *Pallium crassicardo* Conrad, described in the Proc. Acad. Nat. Sci., Phila., p. 313, December 1856; Conrad, Amer. Journ. Conch., Vol. 3, p. 6, 1867; Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 63, 1897; Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, pp. 695, 701, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 49, 1906.

"*Liropecten*" Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 105, 1868-9; Fischer, Man. Conchyl., p. 944, 1887.

Nodipecten Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 695, 1898, type (by original designation) *Ostrea nodosa* Linnæus, Pliocene of Florida and living from the Gulf of Mexico to the north coast of South America, probably also Pacific (as *subnodosus*).

Not to be confused with *Lyriopecten* Hall, 1883, a Paleozoic form.

Type (by subsequent designation, Dall 1898), *Pallium estrellanum* Conrad, upper Miocene of California.

Shell thick, usually large, valves about equally convex; strengthened with large radial ribs upon which and upon the interspaces between which secondary striations are usually developed as on *Pecten maximus;* surface of valves sometimes marked by nodes or concentric constrictions as in *Manupecten;* ventral ear somewhat longer than the dorsal, with a moderate or characteristically shallow byssal notch; interior of hinge often marked with strong cardinal grooves.

Geologic range: Oligocene or lower Miocene to Recent (Atlantic coast); lower Miocene to Recent (Pacific coast).

Distribution: warm waters of the Western Hemisphere.

This subgenus is in several respects similar to *Manupecten;* but it is characterized by its longer hinge line with larger ears, and it nearly always has a larger, heavier shell. In spite of the similarities, the two groups probably were derived independently from the section *Chlamys* of typical *Pecten*, and in their typical development are very distinct. Dall's section *Nodipecten* is based upon distinctions that are of no more than specific significance. The nodose form is represented in varieties of typical species. The large heavy-shelled Pectens that have a parallel development in the Miocene of Europe, *Gigantopecten* Roverto (+ *Macrochlamys* Sacco), are said to be distinguishable by their left valves, which are of low convexity, almost as in typical *Pecten;* but the distinction is of doubtful value and obscures a relationship that may be of considerable importance.

The Lyropectens appear suddenly and practically simultaneously in the lower Miocene of the two sides of the continent. As the correlations between the two regions are still somewhat uncertain, it is not yet safe to say positively in which region the new group of Pectens first made its appearance; but the evidence seems to point strongly to the eastern occurrence being the older. *Pecten jeffersonius* and its varieties, which are represented in specifically indistinguishable assemblages in the Miocene formations along both the Atlantic and Pacific coasts, are the first Lyropectens to appear in the West, but are preceded in the East by at least one older variety of *Pecten madisonius*, a closely related species.[1] Thus, if it be assumed that the migration of *Pecten jeffersonius* between the Atlantic and Pacific coasts took a geologically negligible amount of time, it would indicate that the Vaqueros formation, lower Miocene of California, is not so old as the Alum Bluff group of Florida, formerly thought to be upper Oligocene but now considered lower Miocene. Conrad and others based their original identification of the Pacific coast Miocene on the presence of *Pecten jeffersonius* and similar forms.

It has been well recognized that there was during the Miocene an inter-oceanic connection somewhere in Mexico or Central America through which genera and subgenera and sections of warm-water distribution could migrate; but it has been held highly improbable, a possibility too "theoretical" to be worth looking into, that any *species* could migrate through this passageway. However, the evidence is beginning to accumulate and is in some cases sufficiently complete to show that this entirely illogical view is responsible for the neglect of numerous natural facts that would otherwise have been useful for making correlations. In other words, the California province is not so isolated as it has been considered; some species have been identical on the two sides of the continent, especially at the time when the passageway was open, and in a few cases the species have lived on on one side or the other or even on both sides up to the present day without changing their specific characters sufficiently to become distinguishable. *Pecten jeffersonius* is an example of an extinct species that once lived on both sides, and *Pecten nodosus* is an example of a living species, the Pacific and Atlantic branches of which have remained only doubtfully separable. There are probably many other species in common between the two regions, especially Miocene species, though practically no attempt has been made to recognize them.

Because of the similarity of the California Lyropecten assemblage to that of the Atlantic coast, students in California as well as those in the East will find Dall's excellent account of the variations of the eastern species very useful.[2]

The following is a brief summary of the California Lyropectens, prepared in order to show some of the relations with the eastern species and to show the position of the Pliocene species within the group. It also serves to illustrate the distinction between *Lyropecten* and *Vertipecten*.

Pecten (Lyropecten) jeffersonius Say

Plate 9, Figure 3

Pecten jeffersonius Say, Journ. Acad. Nat. Sci., Phila., Vol. 4, p. 133, pl. 9, fig. 1, 1824; Conrad, Fossils of the Medial Tertiary, p. 46, pl. 22, fig. 1, 1840, republished by Dall, Philadelphia, 1893.

Pecten estrellanus Conrad, U. S. House of Representatives, Doc. No. 129, p. 20, July, 1855; U. S. Pacific R. R. Survey Reports, Vol. 5, p. 329, pl. 9, 1856, the volume reprinted with explanation of plates by Blake, New York, 1858, Conrad's two versions of the original description collated and the description reproduced by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 171, 1909.

Pecten magnolia Conrad, U. S. Pacific R. R. Survey, Reports, Vol. 7, p. 191, pl. 1, fig. 2, 1857, description reproduced by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 181, 1909; Anderson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 100, listed questionably, 1911; Smith, Vol. 3, pp. 165, 173, 178, 1912.

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[1] *Pecten (Lyropecten) madisonius* Say variety *sayanus* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 725, 1898.
Chlamys (Lyropecten) sayanus [*sic.*] Dall, Gardner, Prof. Paper 142-A U. S. Geol. Survey, p. 45, pl. 12, fig. 7, 1926.

[2] Trans. Wagner Free Inst. Sci., Phila., Vol. 3, pp. 722-725, 1898.

"*Liropecten veatchii* Gabb" Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 246 (in part, — "Pliocene," Ojai Valley), 1888.

Not "*Pecten magnolia* Conrad" Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 702, 1898; Nautilus, Vol. 14, p. 117, 1901.

Pecten (Lyropecten) jeffersonius Say, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 722, 1898.

Pecten (Chlamys) jeffersonius Say, Glenn, Maryland Geol. Survey, Miocene Volume, p. 378 (? pl. 100, fig. 2), 1904.

Pecten (Lyropecten) magnolia Conrad, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 77, pl. 24, figs. 1, 2, pl. 25, fig. 1, 1906; Proc. U. S. Nat. Mus., Vol. 32, p. 541, pl. 41, fig. 1, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 14, pl. 28, fig. 1, 1907; Arnold and Anderson, Bull. 322, p. 32, pl. 16, fig. 1, 1907.

Shell large, nearly circular, practically equivalve or with the right valve somewhat the more convex; sculptured with 7 to 13 large, strong ribs, which are wider and closer together on the right valve than on the left, the ribs and interspaces alike being marked by numerous scabrous striations; hinge line long, ears large and nearly squarely terminated, sculptured with numerous fine radial striations, the byssal notch small and shallow; interior of the hinge without the diverging cardinal grooves that are sometimes found in Lyropectens, or with only rudimentary ones.

Dimensions: Altitude, 145 mm.; length, 150 mm.; length of hinge, 105 mm.; diameter of the two valves, 67 mm.

Type specimens: Of *jeffersonius,* location unknown to writers; of *catilliformis*—"The specimen was a cast of the interior of the shell and was too friable to preserve. The drawing was made at the locality by Mr. Koppel, and is of the natural size"—Blake; of *magnolia,* No. 13,311 in the U. S. National Museum (Paratype No. 13,325).

Type localities: Of *jeffersonius,* Miocene of Maryland; of *catilliformis* Miocene (probably Anderson's zone A of the Temblor, which might possibly represent the Vaqueros), Ocoya Creek (now called Poso Creek, near Barker's Ranch), Kern Co., Calif.; of *magnolia,* Vaqueros formation, lower Miocene of the Santa Ynez Mts., Santa Barbara Co., California.

Lower (?) Miocene: Various localities in the Vaqueros formation of southern and middle California (Arnold).
Middle Miocene: ? Temblor of the east side of the San Joaquin basin, Calif. (Blake; Anderson), possibly Vaqueros; Maryland to North Carolina (Dall).

This large characteristic species is a very important marker for the Vaqueros formation in California. It is not surprising that such a form, free-swimming as it was and able to migrate rapidly, should be found on both sides of the continent in approximately the same latitudes in formations that were deposited at a time when the two oceans were connected. It varies greatly in relative dimensions, the most important variety, *septenarius,* being also found on both sides of the continent.

Variety **jeffersonius**, s. s.

Shell with 9 to 13 ribs, usually longer than high.

The type of *magnolia* appears to belong to this typical variety rather than with the fewer ribbed variety that has often been called *magnolia.* The two forms intergrade so completely, however, that the distinction may not be important. The ribs on young specimens are high and squarish; but on adults they become rounded, and sometimes flatten out as on the eastern specimen here figured and on two incomplete western specimens in the Stanford University collection. Dall distinguishes an eastern variety *edgecombensis* Conrad with 12 to 17 ribs which approaches closely the eastern *P. madisonius* Say, although, as Dall explains, it can be distinguished from *madisonius* by its byssal ear, which is "sculptured with fine uniform numerous threads," and by its notch, which is "shallow and leaves an inconspicuous fasciole." *P. miguelensis* Arnold resembles *edgecombensis* in several respects, including the tendency to have a midrib; and as there are in the Stanford University collection some poorly preserved California specimens from an unknown locality that resemble *madisonius*, it may be possible in the future to show that practically the whole eastern assemblage is represented in California.

The more numerous ribbed varieties of *jeffersonius* sometimes resemble *P. magnificus* variety *crassicardo*, and indeed the latter is probably a direct descendant. *P. magnificus* variety *crassicardo* can, however, be distinguished by its more numerous ribs, by the fewer, coarser riblets on the ears, and by the strongly developed diverging grooves on the inside of the hinge.

Pecten (Lyropecten) jeffersonius Say variety **septenarius** Say

Pecten septenarius Say, Journ. Acad. Nat. Sci., Vol. 4, p. 136, pl. 9, fig. 3, 1824; Conrad, Fossils of the Medial Tertiary p. 47 (spelled *septemnarius*), pl. 22, figs. 2, 1840, republished by Dall, Philadelphia, 1893.

Pecten jeffersonius var. *septenarius* Say, Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 722, 1898; Glenn, Maryland Geol. Survey, Miocene Volume, p. 379, pl. 100, fig. 4, 1904.

Pecten magnolia Conrad, in part, of California authors.

Shell like that of the typical variety but often somewhat narrower, with fewer (7-9), sometimes broader ribs.

Dimensions: Altitude, 145 mm.; length, 140 mm.; length of hinge, 105 mm.; diameter of two valves, 65 mm.

Type locality: Miocene of Maryland.

Lower (?) Miocene: Vaqueros formation near its type locality (Wayne Loel) and in various other places in middle and southern California.

This variety intergrades perfectly with the typical variety, but in its extreme development has quite a distinctive appearance. It is probably from such a form as this that *P. nodosus* was derived, the latter with its varieties *subnodosus* and *veatchii* being distinguishable by the coarser secondary striations on the ribs, the coarser riblets on the ears, the relatively shorter dorsal ears, the nodosity of the ribs, and the diverging grooves on the inside of the hinge.

Pecten (Lyropecten) miguelensis Arnold

"Pecten heermanni Conrad," Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 701, 1898 (*fide* Arnold).

Pecten (*Lyropecten*) *miguelensis* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 79, pl. 22, figs. 1, 1*a*, 1*b*, pl. 23, fig. 1, 1906.

This form is intermediate in general characters between *Pecten magnificus* variety *crassicardo* and *P. estrellanus*, having 17 or 18 prominent rounded ribs which are wider than the interspaces, both the ribs and the interspaces being ornamented by longitudinal striæ as on *crassicardo*, and having a prominent mid-rib as on *estrellanus*. The left valve of the type is depressed behind the umbones, but this feature is probably not a characteristic of the species. *P. miguelensis* is distinguished from *crassicardo* by the wider ribs and narrower interspaces on the right valve and by the mid-rib. From *estrellanus* it is distinguished by stronger striation, higher, rounder ribs, and larger size.

There are in the collection at Stanford University some poorly preserved specimens from the lower or middle Miocene of California, locality uncertain, that are marked *miguelensis*. It is not unlikely that they represent *P. madisonius* Say, or *P. jeffersonius* variety *edgecombensis* Conrad, though the riblets on the ears are coarser. *Pecten miguelensis* originally came from the Miocene of San Miguel Island, and is now considered characteristic of the lower Miocene. It may be that *P. jeffersonius* evolved into the upper Miocene forms *estrellanus* and *crassicardo* through the form *catilliformis* (+ the true *magnolia*, not *septenarius*) and through this species.

Pecten (Lyropecten) nodosus (Linnæus)

Ostrea nodosa Linnæus, Syst. Nat., Ed. 10, p. 697, 1758.

Pecten corallinus Chemnitz, Neues Syst. Conch. Cab., Vol. 7, p. 306, pl. 64, figs. 609-611, 1874.

Ostrea decemradiata Gmelin in Linnæus, Syst. Nat., Ed. 13, p. 3329, 1790.

Pecten nodosus Linnæus, Lamarck, Hist. Anim. s. Vert., Vol. 6, p. 170, 1819, Desh. and M. Edw. Ed., Vol. 7, p. 139, 1836; Sowerby, Thes. Conch., Vol. 1, p. 66, pl. 15, fig. 115, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 3, species 15, 1852; Heilprin, Trans. Wagner Free Inst. Sci., Phila., Vol. 1, p. 100, 1887.

Pecten corallinoides d'Orbigny in Webb and Berthelot, Histoire Naturelle des Îles Canaries, Vol. 2, Pt. 2, p. 102, 1836-44; Sowerby, Thes. Conch., Vol. 1, p. 65, pl. 12, figs. 3, 4, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 6, fig. 27, 1852.

? *Pecten fragosus* Conrad, Journ. Acad. Nat. Sci., Phila., Ser. 2, Vol. 1, p. 214, pl. 39, fig. 11, 1849.

"*Pecten magnificus* Sowerby" Gabb, Geol. Santo Domingo, p. 256, 1873; Pilsbry, Proc. Acad. Nat. Sci., Phila., for 1921, p. 409, 1922.

Pecten pernodosus Heilprin, Trans. Wagner Free Inst. Sci., Phila., Vol. 1, p. 131, pl. 16*b*, figs. 69, 69*a*, 1887.

Lyropecten nodosus Linnæus, Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 91, 1897.

Pecten (*Nodipecten*) *nodosus* Linnæus, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, pp. 695, 717, 728, 1898; Maury, Bulls. Amer. Paleo., Vol. 5, pp. 350, 442 (or Bull. 29, p. 186, Bull. 30, p. 26), 1917; Vol. 8, p. 59 (or Bull. 34, p. 27), 1920; Woodring, Mem. Geol. Survey of the Dominican Republic, No. 1, pp. 125, 144, 1921.

Pecten (*Lyropecten*) *pittieri* Dall, Smithsonian Misc. Coll., Vol. 59, p. 10, 1912; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 23, pl. 17, fig. 6, 1925.

Shell of medium or large size, circular, valves of approximately equal convexity, sculptured with large rounded ribs, 8-12 in number, with about equal interspaces, ribs and interspaces alike marked by numerous rather strong striations, the ribs, especially the largest three of the left valve, periodically interrupted by hollow bulbous nodes; hinge line about half the length of the shell, the ventral ears sometimes twice as long as the dorsal, sculptured usually with five strong riblets, the byssal ear sometimes with a few smaller ones on the narrow byssal scar and the others when adult usually with a set of intercalaries almost as large as the primaries and a few additional smaller riblets toward the base, byssal ear rounding into the rather small V-shaped notch, ctenolium strong; hinge with moderately developed diverging grooves on the inside.

Dimensions (Venezuela specimen): Altitude, 102 mm.; length, 104 mm.; length of hinge, 54 mm.; diameter of the two valves, 40 mm.

Type specimen: Of *pittieri*, No. 214,368 in the U. S. National Museum.

Type localities: Of *nodosus*, African and Indian oceans; of *corallinus*, Danish West Indies; of *corallinoides*, Canary Islands; of *fragosus*, West Indies; of *pernodosus*, Pliocene deposits of the Caloosahatchie, Florida; of *pittieri*, Pleistocene of Costa Rica.

Miocene: Dominican Republic (Maury, Woodring).

Pliocene: Domincan Republic (Maury); of the Caloosahatchie (Heilprin, Dall).

Pleistocene: Antilles and the north coast of South America (Dall); Costa Rica (Dall).

Living: East Africa (Linnæus, Reeve as *corollinoides*); West Africa (Chemnitz, etc.); Isle of Ascension (Lister); Canary Islands (d'Orbigny); Gulf of Mexico and the Antilles, and probably also (as *P. subnodosus*) on the Pacific shores of middle America (Dall).

Those who dogmatically assert that no species can occur in widely separated localities will throw up their hands in horror at the distribution cited above. Nevertheless, the shells are there and are so similar that so far as the present writers could discover no one has yet found any characters of more than individual or possibly varietal significance by which to distinguish them. Even if, from the comparison of many specimens, means are found to distinguish the various local groups, the essential and most significant fact will remain that this form has, since the beginning of the Miocene, migrated nearly around the world. If the local groups are separated nomenclatorially, what will be gained by this sacrifice of the expression of the natural history of the group? *Pecten gibbus* has nearly the same history and distribution. It may be that Pectens, because of their rapid means of locomotion, can travel more widely (provided the climate suits them) than other mollusks; but examples of similar occurrences in other genera are coming to light.

Pecten nodosus varies considerably, and it is useful to recognize some of the most distinctive forms as varieties. No attempt is here made to separate any varieties except those that occur on the Pacific coast of America. The species as a whole can be distinguished from *P. jeffersonius* by its shorter hinge line and by its coarser radial striations on the ribs and ears.

Variety **nodosus**, s. s.

Shell circular, of moderate size and thickness; ribs on the right valve 10 in number, nearly equal in size and character, seldom nodose, ribs on the left valve 9 in number, usually with prominent hollow bulbous nodes, of which the largest are on the middle rib, the first pair of ribs on each side of the middle rib smaller and with smaller nodes, the second pair large, with large nodes, the third pair small like the first pair, and the last pair small but with fairly prominent nodes, the larger ribs of the left valve corresponding to wider interspaces on the right.

This typical variety is distinguished from the form of *subnodosus* figured by Reeve only by having one less rib. The specimens in the Oldroyd Collection at Stanford University show no other difference, and it is very likely that this one is not of significance. It is almost a certainty that with more material, specimens from the Pacific coast will appear that are indistinguishable from the typical form. Antillean specimens have various colors, carmine, maroon, orange, etc., and Chemnitz mentions among other specimens an orange one from the coast of Guinea, West Africa. It might be mentioned that Chemnitz has an excellent, perhaps the best, description of the typical form of this species, and that his name is binomial, and his illustrations and synonymy very helpful. Hence, if the name *nodosus* is restricted to the east African form, *corallinus* should be the name for the West Indian. Dall (1898) gives a good account of the variations in the nodosity of the West Indian form.

Pecten (Lyropecten) nodosus (Linnæus) variety **subnodosus** Sowerby

Pecten subnodosus Sowerby, Proc. Zool. Soc. London, p. 109, 1835; Thes. Conch., Vol. 1, p. 65, pl. 15, figs. 97, 112, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 4, species 20, 1852.

"*Pecten magnificus* Sowerby," on collection labels and sometimes cited in the literature as a synonym of *subnodosus*, probably Sowerby's form β of *magnificus* but not the typical form.

Shell like that of the typical variety but with one more rib on each valve, there being two small ribs back of the middle rib of the left valve instead of one, and on the right valve a group of three ribs instead of two back of the wide central interspace.

Dimensions: Like those of the typical variety.

Living: Panama and West Colombia.

The present writers follow Reeve's example in selecting Sowerby's form β of *subnodosus* to bear the name. This variety is represented in the Oldroyd Collection at Stanford University by six Pacific coast specimens, all having the extra rib and all of a maroon color. This variety is exactly intermediate in the rib character between *nodosus, s. s.*, and variety *vaughani*. Sowerby's form α from the Gulf of California was named *intermedius* by Conrad, and is somewhat better distinguished from *nodosus*, but only varietally. Sowerby's form γ is from the Atlantic, indicating that this variety may also occur in the Atlantic. Reeve's figure is of the left valve and shows more plainly the extra rib.

Pecten (Lyropecten) nodosus (Linnæus) variety **vaughani** Arnold

Pecten (Lyropecten) vaughoni Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 81, pl. 23, figs. 3, 3*a*, 3*b*, 1906.

"*Pecten subnodosus* Sowerby," Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 474, pl. 25, fig. 6, 1926.

Pecten (Lyropecten) modulatus Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 11, pl. 3, fig. 6, 1925.

Shell like that of the typical variety but smaller, with two more ribs on each valve, there being two small ribs on each side of the middle rib of the left valve instead of one as in the typical variety, and on the right valve groups of three ribs instead of two on each side of the central wider interspace.

Dimensions: Altitude, 37 mm.; length, 39 mm.; length of hinge, 23 mm.; diameter of the two valves, 16 mm.

Type specimens: Of *vaughani*, No. 9, of *modulatus*, No. 43, in the type collection at Stanford University.

Type localities: Of *vaughani*, Ojai Valley, Ventura Co., probably on the ridge between the Ojai Valley and the Upper Ojai Valley; of *modulatus*, Pliocene of Scammons Lagoon, Lower California.

L. Miocene: Type locality of *vaughani*.

Pliocene: Type locality of *modulatus;* also Coyote Mt., Imperial Co., Calif. (Hanna).

This variety is still very poorly known, being represented by only two authentic specimens, and these are probably immature. It is distinguished from the young of the living west Colombia form of *subnodosus* only by its additional rib in front of the median line, the other differences between the two forms being accounted for by the probable immaturity of *vaughani*. The living specimens of *subnodosus* referred to above sometimes have a slightly stronger riblet in the center of the interspaces, and on the early part of the shell this may be the only riblet. On the type of *P. modulatus* this middle riblet seems to have been inadvertently accentuated during the excavating of the ribs. In *vaughani*, on the other hand, the secondary riblets are all worn nearly smooth by natural erosion, being not essentially different from those on the living form.

Pecten (Lyropecten) nodosus (Linnæus) variety **intermedius** (Conrad)

Lyropecten intermedius Conrad, Amer. Journ. Conch., Vol. 3, p. 7, 1867.

Pecten (*Nodipecten*) *subnodosus* Sowerby, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 128, pl. 52, fig. 1, pl. 53, figs. 1, 1*a*, 1906; Böse, Parergones del Inst. Geol. de Mexico, Vol. 2, pp. 41-43, 1907, says the species should be reunited with *nodosus*.

? *Pecten subnodosus* Sowerby, n. var., Kew, Univ. Calif. Publ. Geol., Vol. 8, p. 46, 1914.

Pecten subnodosus Sowerby, Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Pecten (*Lyropecten*) *subnodosus* Sowerby, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 418, 1926; Hanna and Hertlein, Vol. 16, p. 142, 1927.

Shell like that of the typical variety, having the same number of ribs, but tending to grow larger and heavier, the ribs usually with smaller nodes that are confined to the younger stages of growth, and the secondary striations on the ribs and interspaces becoming more numerous in the adult than on the typical form.

Dimensions: Altitude, 150 mm.; length, 165 mm.; length of hinge, 85 mm.; diameter of the two valves, 70 mm.

Type specimen: In the U. S. National Museum.

Type locality: Cape San Lucas, Lower California.

Pliocene: Loreto, Santa Antonita Pt., Coronados Is., Lower California (Hanna and Hertlein); Cedros Island and Turtle Bay, Lower California (Jordan and Hertlein); ? Pliocene of Temescal Canyon, Santa Monica, Los Angeles Co., Calif. (Rivers in Arnold).

Pleistocene: Lower Quaternary, Magdalena Bay, Lower California (Jordan); La Paz, Mexico (Böse); upper Pleistocene, coast of Oaxaca, Mexico (collected by R. H. Palmer).

Living: Scammons Lagoon, Lower California, to the mainland of Mexico; also reported south to Ecuador (Jordan).

Practically all the differences between this form and the typical are functions of its larger size. It is a geographic variety growing larger where the conditions are better suited for it. Smaller specimens have the shape, coloration, and ribbing of the specimen from Zanzibar figured by Reeve as *corallinoides*.

The fragmentary specimen reported by Arnold from the upper San Pedro formation of Deadman Island, San Pedro, as a variety with 17 ribs is a *P. estrellanus* var. *cerrosensis*, or possibly a *P. magnificus* var. *crassicardo*, but the occurrence is somewhat questionable. The specimen is now in the collection at Stanford University. It may be a redeposited fragment from an older formation.

Pecten (Lyropecten) nodosus (Linnæus) variety **veatchii** Gabb

? "*Pecten nodosus* Linnæus," Sowerby, Thes. Conch., Vol. 1, p. 66 in part, pl. 17, fig. 147, 1842.
Pecten veatchii Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 32, pl. 10. fig. 56, 1866.
Liropecten veatchii Gabb, Cooper, Seventh Ann. Rept. Calif. St. Mineralogist, p. 246, 1888.
Pecten (Nodipecten) veatchii Gabb, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 106, pl. 40, figs. 1, 1*a*, 1906.
Pecten (Lyropecten) veatchii Gabb, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 418, 1926.

Shell like that of the typical variety or the variety *intermedius*, with the same number and arrangement of ribs, but with the strong ribs of the left valve unusually broad and the small ribs unusually narrow, this character being reflected in the interspaces of the right valve.

Dimensions: Altitude, 130 mm.; length, 145 mm.; length of hinge, 75 mm.; diameter of the two valves, 50 mm.

Type specimen: At the University of California.

Type locality: Pliocene of Cedros Island, Lower California.

Pliocene: Known only from the type locality.
? *Living:* East coast of South America (Sowerby).

This variety illustrates very well the normal pattern of ribs in the species *nodosus*, having the differentiation accentuated so that it can be seen more plainly. On some specimens from the type locality there are stronger concentric constrictions which make the right valve appear nodose also, as in some forms of *Pecten swiftii* and as in the form of typical *nodosus* called *pernodosus* by Heilprin. The writers believe that this character is the result of more marked seasonal changes in the environment, and that not being of genetic significance it should not be recognized in the nomenclature. The form with the constrictions occurs with and intergrades with the normal form, and even on the type specimen lesser constrictions are visible.

Pecten (Lyropecten) magnificus Sowerby

Plate 9, Figure 1; Plate 10, Figure 6

Pecten magnificus Sowerby, Proc. Zool. Soc. London, p. 109, 1835; Thes. Conch., Vol. 1, p. 65, pl. 15, fig. 114, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 2, species 9, 1852.

Shell large, circular, sculptured with large rounded ribs as in *P. nodosus* with moderately strong superimposed striations and sometimes small hollow bulbous nodes on the early part of the left valve, rib arrangement as in *nodosus* variety *vaughani* but with the differentiation usually rather obscure and with one or two extra pairs of ribs added at the sides so that the total number becomes 14 for the right valve and 13-15 for the left; hinge line a little more than half the length of the shell, ears as in *nodosus* except that the radial striations are fewer and more distant, three or four strong ones on the byssal ear and either four on the others or else the four dividing into eight or nine smaller ones.

Dimensions (of large specimen from the type locality): Altitude, 160 mm.; length, 175 mm.; length of hinge, 97 mm.; diameter of the two valves, 75 mm.

Type specimen: In the Museum Cuming, London (?).

Type locality: Galapagos Islands.

Although this species is obviously related to *P. nodosus*, it is better distinguished than any of the forms here considered varieties of that species; and yet it has hardly been accorded recognition and has been listed as a synonym or a doubtful variety of *nodosus*, whereas the other forms have sometimes been separated into different sections. It is distinguished from *nodosus* by its more numerous ribs, by its smaller nodes, and by the sparser striations on the ears, although the last character is not particularly significant, as some Antillean specimens of *nodosus*, *s. s.*, do not develop the intercalaries and have almost as few riblets.

The writers were shocked to discover that typical specimens of *crassicardo* are indistinguishable from living specimens of *magnificus* except in the one respect that *crassicardo* seldom has any of the small bulbous nodes. The nodosity appears to increase in *P. nodosus* from higher to lower latitudes, and it is quite probable that the *nodosity* of the living *magnificus* is a result of the warmer water environment. In any case, a comparison of specimens shows beyond any reasonable doubt that the upper Miocene guide fossil in California lived over as *magnificus* on the Galapagos Islands; and as the only difference that has developed in the living form may be attributed to the local environment and may not be of genetic significance at all, the latter can hardly be recognized as more than varietally distinct. It is regrettable that such a well-known name as *crassicardo* has to take a subordinate position; but it seems better to recognize the natural relations than to hide our heads in the sand and try to forget about them. The discovery of a living *crassicardo* or of an upper Miocene *magnificus* does not in the least injure the value of *crassicardo* in California as an index fossil, for the mollusks in the Tertiary formations are used chiefly as indicators of climatic conditions; and it is apparent that *crassicardo* migrated southward at the end of the Miocene, giving place to the cooler climates of the Pliocene, and that it can still be used, especially when abundant, as an index to the upper Miocene in California. A recognition of the occurrence of this specific stock in the higher horizons of more southerly latitudes may, if correct, help paleontologists to avoid mistakes in making correlations, especially if more examples are found in later warm-water horizons of southern latitudes. The discovery of a living branch of the *crassicardo* stock may explain the presence of a 17-rib variety of "*subnodosus*" in the warm-water upper San Pedro of San Pedro.

Variety **magnificus**, s. s.

Shell with small bulbous nodes on the earlier part, especially on the three strongest ribs of the left valve.

Pecten (**Lyropecten**) **magnificus** Sowerby variety **crassicardo** (Conrad)

Plate 9, Figures 4, 5

Pallium crassicardo Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 8, p. 313, December, 1856, reprinted by Dall, Prof Paper 59 U. S. Geol. Survey, p. 173, 1909.

Spondylus estrallensis Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 8, p. 315, December, 1856, reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 175, 1909, not *Pallium estrellanum* Conrad, p. 313, ahead of *crassicardo*.

Spondylus estrellanus Conrad, U. S. Pacific Railroad Survey, Reports, Vol. 7, p. 191, pl. 1, fig. 3, 1857, description reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 182, 1909, not *Pallium estrellanum* Conrad.

Lyropecten crassicardo Conrad, Proc. Acad. Nat. Sci., Phila., p. 291, 1862; Amer. Journ. Conch., Vol. 3, p. 6, 1867.

Liropecten crassicardo Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 105, wholly or in part, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 246, wholly or in part, 1888.

"*Pecten estrellanus* Conrad," Cooper, Bull. No. 4, Calif. St. Mining Bureau, p. 57, in part, 1894.

"*Pecten magnolia* Conrad," Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 702 in part, 1898; Nautilus, Vol. 14, p. 117 in part, 1901.

Pecten (*Lyropecten*) *diabloensis* Arnold MS., 1904; Prof. Paper 47 U. S. Geol. Survey, p. 72, 1906, not *Pecten diabloensis* Clark in Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 176, 1924.

Pecten (*Lyropecten*) *crassicardo* Conrad, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 71, pl. 16, figs. 1, 1*a*, pl. 17, figs. 1, 1*a*, 1*b*, pl. 18, figs. 1, 2, 2*a*, 1906; Proc. U. S. Nat. Mus., Vol. 32, p. 542, pl. 44, fig. 1, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pp. 14, 147, pl. 31, fig. 1 (same figure), 1907; Arnold and Anderson, Bull. 322, p. 32, pl. 18, fig. 1, 1907; Clark, Univ. Calif. Publ. Geol., Vol. 8, pl. 46, fig. 3, 1915; Hertlein and Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 623, 1927.

Pecten (*Liropecten*) *crassicardo* Conrad, Weaver, Univ. Calif. Publ. Geol., Vol. 5, p. 262, 1909.
Pecten crassicardo Conrad, Arnold, Bull. 396 U. S. Geol. Survey, pp. 17, 21, 22, 25, 27, pl. 12, fig. 1, Jan. 15, 1910; Arnold and Anderson, Bull. 398, pp. 85, 86, 94, 95, 109, 111, pl. 34, fig. 1, 1910; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 167, 173, 1912; Anderson and Martin, Vol. 4, p. 47, 1914; McLaughlin and Waring, Map Folio accompanying Bull. 69, Calif. St. Mining Bureau, pl. 1, fig. 39, 1914; Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 419, 426, 435, pl. 45, fig. 3, 1915; Nomland, Vol. 10, pp. 300, 302, 303, 1917; Trask, Vol. 13, pp. 142, 144, 1922.
? Not "*Pecten crassicardo* Conrad," Guppy, Proc. Agri. Soc. Trinidad and Tobago, Vol. 10, p. 453 (Society Paper No. 440, p. 7), 1910, reprinted in Bulls. Amer. Paleo., Vol. 8, p. 298 (or No. 35, p. 150), 1921 = *? Pecten archon* Maury.
Pecten (*Pallium*) *holwayi* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 454, pl. 47, fig. 5, 1915.
Pecten crassicardo biformatus Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 307, pl. 18, fig. 1 only (the type), pl. 19, fig. 4, 1917.
Pecten (*Lyropecten*) *ricei* Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 148, pl. 2, fig. 1 only (the type), 1922.
Pecten (*Lyropecten*) *vickereyi* Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 148, pl. 4, fig. 1, 1922.

Shell like that of the typical variety but without the hollow nodes; ribs varying from 14 to 17 in number.

Dimensions: Altitude, 160 mm.; length, 165 mm.; length of hinge, 115 mm.; convexity of the two valves, 65 mm.

Type specimens: Of *crassicardo*, at the Academy of Natural Sciences, Philadelphia; of *holwayi*, at the University of California; of *biformatus*, No. 11,308, of *ricei*, No. 12,364, at the University of California; of *vickereyi*, No. 26, at Stanford University.

Type localities: Of *crassicardo*, Monterey Co., Calif., probably upper Miocene; of *holwayi*, San Pablo Bay, upper Miocene; of *biformatus*, Tejon Hills, Kern Co., upper Miocene; of *ricei* and *vickereyi*, Briones formation, upper Miocene of the San Francisco Bay district.

Middle Miocene: Reported by Arnold and others, but not common.
Upper Miocene: Common and characteristic throughout middle and southern California.

This variety, as explained above, is not well distinguished from the typical variety, and it would not be surprising to find it along with the typical variety in the Pliocene and Recent of more southerly latitudes. It developed side by side with *estrellanus* from a form intermediate between it and *nodosus*, and among the many variations of *crassicardo* and *estrellanus* there are a number that approach each other so closely that it is difficult to assign them with confidence to either species. However, the characteristic forms appear to be more common than the intergrades, and it is best for the present to keep the species separate. *P. estrellanus* is distinguished by its broader, flatter ribs, on the top of which the radial striations are faint, by the inter-rib that is commonly present between the main ribs, and by the more numerous riblets on the ears. The two stocks appear to have been diverging, although the Pliocene variety *cerrosensis* of *estrellanus* is again intermediate between them. Some variations of *crassicardo*, like the ones here illustrated, show a differentiation of the ribs as in *nodosus*.

Pecten (Lyropecten) magnificus Sowerby variety **hamiltoni** Arnold

Pecten (*Lyropecten*) *crassicardo* var. *hamiltoni* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 73, pl. 11, figs. 5, 6, 1906.
? Pecten (*Plagioctenium*) *neahensis* Arnold, Prof. Paper 47, U. S. Geol. Survey, p. 87, pl. 15, figs. 2, 2*a*, 2*b*, 1906.

Shell smaller, with about 17 smaller, rounder ribs, and narrower interspaces.

This variety is known from the upper Miocene of middle California; and if *P. neahensis*, the figure of which is very similar, is included, it occurs also in the middle and upper Miocene of Neah Bay, Washington.

Pecten (Lyropecten) pretiosus Hertlein

Pecten (Lyropecten) pretiosus Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 12, pl. 2, fig. 6, pl. 3, fig. 4, 1925; Hertlein and Jordan, Vol. 16, p. 624, 1927.

Shell small, having both valves very convex and contracted around the margins, strengthened with 14 to 16 moderately prominent rounded ribs, and covered with radial striations.

Type specimen: No. 38 in the type collection at Stanford University.

This species or pathologic variation is found at several localities in Lower California, at horizons believed to be the equivalent of the lower Temblor (middle Miocene) of California. It resembles very closely *Pecten eldridgei*, Arnold, and like that species appears to be a stunted or pathologic form of its group. It can be distinguished from *eldridgei* by its more rounded, more distant, longitudinally striated ribs, and sometimes (but not always) by the more grooved interior of the hinge.

Pecten (Lyropecten) estrellanus (Conrad)

Plate 8, Figure 4

Pallium estrellanum Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 8, p. 313 (ahead of *crassicardo*), December, 1856, reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 173, 1909; U. S. Pacific Railroad Reports, Vol. 6, p. 71, pl. 3, fig. 15, 1857, description reprinted by Dall, *op. cit.*, p. 178, 1909; U. S. Pacific Railroad Reports, Vol. 7, p. 191, pl. 3, figs. 3, 4, 1857, description reprinted by Dall, *op. cit.*, p. 182, 1909; not *Spondylus estrellanus* Conrad (= *Pecten crassicardo*), U. S. Pacific Railroad Reports, Vol. 7, p. 191, pl. 1, fig. 3, 1857, description reprinted by Dall, *op. cit.*, p. 182, 1909.

Lyropecten estrellanus Conrad, Proc. Acad. Nat. Sci., Phila., Ser. 2, Vol. 6, p. 291, 1862; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 105, 1868-9.

Lyropecten volæformis Conrad, same references as for *Lyropecten estrellanus*.

Liropecten estrellanus Conrad, Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 246, 1888; Bull. No. 4, Calif. St. Mining Bureau, p. 57 in part, pl. 5, figs. 65-67, 1894.

"*Pecten heermanni* Conrad," Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 701 in part, 1898; Nautilus, Vol. 14, p. 117, 1901.

Pecten (Lyropecten) estrellanus Conrad, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 74, pl. 19, figs. 1, 1*a*, pl. 20, figs. 1, 2, 2*a*, pl. 21, figs. 1, 1*a*, 1*b*, 2, 2*a*, 2*b*, 1906; Proc. U. S. Nat. Mus., Vol. 32, p. 541, pl. 41, fig. 2, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pl. 28, fig. 2 (same figure), 1907.

Pecten estrellanus Conrad, Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 350, 1908; Bull. 396 U. S. Geol. Survey, pp. 17, 21, 22, 25, 27, pl. 10, fig. 3, Jan. 15, 1910; Arnold and Anderson, Bull. 398, pp. 85, 86, 94, 95, 101, 102, 106, 107, 109, 110, 111, 112, pl. 32, fig. 3, 1910; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 167, 173, 1912; Anderson and Martin, Vol. 4, p. 47, 1914; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, 1915; Nomland, Vol. 10, pp. 299, 300, 303, 304, 1917.

Pecten (Lyropecten) ricei Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 148 in part, pl. 2, fig. 2 only (probably a worn left valve), 1922.

Shell large, biconvex, strengthened with 16 to 20 broad, flat-topped, comparatively low, vertical-sided ribs, with narrower interspaces, each of which usually contains a distinct mid-rib, interspaces on the right valve much narrower than the ribs, containing, as a rule, merely the mid-rib with a narrow groove on each side of it, although on a few specimens there are longitudinal striations on the ribs and interspaces as in *miguelensis* and *crassicardo*, especially near the margins of the shell, these striations being much fainter and less persistent, only in the interspaces of the left valve are the striations prominent, there being usually one or two auxiliary striations on each side of the mid-rib; ears with more numerous radiating riblets than is usual for *crassicardo*.

This species is distinguished from *P. miguelensis* by its lower, smoother, squarer ribs. From *crassicardo* it can also be told by its mid-rib.

Variety **estrellanus**, s. s.

Shell with moderately arched valves and usually about 17 to 19 ribs.

Miocene: Vaqueros (Arnold 1909, questionably identified; Smith); Temblor (Arnold 1908, listed as Vaqueros; Smith); Briones (Trask); San Pablo (Clark; Arnold; etc.); Santa Margarita (Nomland).

Pliocene: Jacalitos (lower Etchegoin) (Arnold 1910); lower Pico of locality 209, Elsmere Canyon, Los Angeles County, three specimens, one of which is characteristic, the others are somewhat intermediate between this variety and variety *catalinæ* (H. R. G.).

The form identified by Conrad as *Pallium estrellanum* in Vol. 7 of the Pacific Railroad Reports and later renamed by him *Lyropecten volæformis* has a strongly arched right valve. Conrad thought that the unattached flat valve which he collected with his original specimen was the left valve, but Arnold has pointed out that he probably was in error.

The typical variety, like *crassicardo*, is reported from the Vaqueros and Temblor, but the early records are doubtful and the species does not become common and branch out into many variations until the upper Miocene. A few stragglers lived over into the lowermost Pliocene.

Pecten (**Lyropecten**) **estrellanus** (Conrad) variety **terminus** Arnold

Pecten (*Lyropecten*) *estrellanus* Conrad variety *terminus* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 77, pl. 23, figs. 2, 2*a*, 1906.

Pecten estrellanus var. *terminus* Arnold, Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 173, 1912; Nomland, Univ. Calif. Publ. Geol., Vol. 9, pp. 81, 203, 204, 205, 208, 1916.

Pecten terminus Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 212, 213, 219, pl. 6, fig. 4, 1917.

Shell with fewer, broader ribs, usually about 15; rather convex.

U. Miocene: San Pablo (Arnold; Smith).

L. Pliocene: Jacalitos (Nomland, 1916); common in the *Chione elsmerensis*, and *Turitella nova* zones of the Etchegoin of the Coalinga district (Nomland, 1917).

Pecten (**Lyropecten**) **estrellanus** (Conrad) variety **catalinæ** Arnold

Pecten (*Lyropecten*) *estrellanus* Conrad variety *catalinæ* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 76, pl. 20, figs. 3, 3*a*, 4, 1906; Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 25, 1907.

Pecten estrellanus var. *catalinæ* Arnold, Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 173, 1912.

? *Pecten* (*Plagioctenium*) *crassiradiatus* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 450, pl. 47, fig. 7, 1915.

Pecten crassicardo biformatus Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 307 (typ. err. *biformatis*), in part, pl. 18, figs. 1*a*, 1*b*, only, 1917.

Pecten estrellanus catalinæ Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 215, 227, 1917.

Pecten mediacostatus Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 472, pl. 22, fig. 6, pl. 24, fig. 2, 1926.

Shell with very low convexity, low ribs, and practically no striations.

Type specimen: No. 30 in the type collection at Stanford University.

? *Miocene:* Near the Isthmus, Santa Catalina Island, with the typical variety (Arnold, type locality); ? San Ardo and vicinity, Monterey Co. (Arnold); San Pablo (Clark, as *crassiradiatus*).

L. Pliocene: Temescal Canyon, Santa Monica Mts., Los Angeles Co. (Watts in Arnold); Elsmere Canyon (Arnold 1907; Eldridge and Arnold); lower Etchegoin of Big Sandy and Whalen Creeks, Priest Valley Quadrangle, Monterey County (Nomland); south side of Coyote Mt., Carrizo Creek district, Imperial Co. (Hanna, as *mediacostatus*).

The forms described by Hanna and Clark appear to be poorly preserved distorted variations.

Pecten (Lyropecten) estrellanus (Conrad) variety **cerrosensis** Gabb

Plate 8, Figures *1a*, *1b*, *2a*, *2b;* Plate 9, Figure 2

Pecten cerrosensis Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 32, pl. 9, figs. 55, 55*a*, 1866, p. 103, 1868-9.

"*Pecten estrellanus* Conrad," Ashley, Proc. Calif. Acad. Sci., Ser. 2, Vol. 5, p. 338, 1895.

Not "*Pecten* (*Plagioctenium*) *cerrosensis* Gabb," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 123, pl. 44, fig. 5, pl. 49, figs. 1, 1*a*, 1*b*, 1906.

Pecten (*Lyropecten*) *ashleyi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 122, pl. 42, figs. 1, 1*a*, pl. 48, fig. 1, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 152, pl. 34, fig. 2, 1907.

? "*Pecten* (*Nodipecten*) *subnodosus* Sowerby, variety with 17 ribs," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 129, 1906.

Pecten ashleyi Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914.

Pecten (*Plagioctenium*) *cerrosensis* Gabb, Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 15, pl. 6, fig. 1, 1925.

Pecten (*Lyropecten*) *cerrosensis* Gabb, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 432, pl. 32, fig. 4, 1926.

Pecten (*Lyropecten*) *gallegosi* Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 434, pl. 29, fig. 1, 1926.

Shell like that of the typical variety but somewhat larger, the ribs narrower and the mid-rib not always distinct, ribs varying in number from 16 to 20; striations on the ears rather numerous, sometimes increased to twice the number by the development of intercalaries.

Dimensions: Altitude, 150 mm.; length, 160 mm.; length of hinge, 90 mm.; convexity of the two valves, 55 mm.

Type specimen: At the University of California.

Type locality: Pliocene of Cedros Island, Lower California.

Pliocene: Type locality; Newhall tunnel district, Los Angeles Co. (Ashley); Third Street tunnel, Los Angeles (Arnold); Elsmere Canyon, Los Angeles Co. (Arnold, English); San Diego (Dall and Stearns in Arnold); Puente Hills, Orange Co. (Eldridge in Arnold); Casmalia, Santa Barbara Co. (F. M. Anderson in Arnold); localities 211-214, 217, 228, 257, 263, etc., S. D. S. N. H., middle Pliocene from the Newhall tunnel district to Holser Canyon, Los Angeles Co., numerous specimens (H. R. G.); loc. 201 S. D. S. N. H., upper horizon in Elsmere Canyon, two fragments (H. R. G.).

? Pleistocene: Upper San Pedro series of Deadman Island, San Pedro Harbor, Los Angeles Co. (Arnold).

This variety is usually reported only from localities previously known to be Pliocene. The distinctions between this variety and the typical and between this variety and *catalinæ* are of doubtful significance. The large specimen here illustrated is a distorted gerontic individual of the form originally described by Gabb, the other specimens being more normal and more common. On the specimen from locality 217*b* can be seen a differentiation of the ribs, especially those of the left valve; and it will be noticed that there are groups of three lower ribs on each side of the large central rib, corresponding to the groups of two in *magnificus* and in *nodosus* variety *vaughani* and to the single low rib of *nodosus*, *s. s.* This differentiation can be seen on Arnold's San Pedro Pleistocene specimen, and the group of lower ribs is a group of three. On *magnificus* and its varieties there may be almost as many ribs, but the extra ones are added outside of the larger ribs that bound the groups of two. On the right valve of some specimens of *cerrosensis* there are obscure groups of four ribs, the ribs being all of approximately equal strength, and the groups being recognizable only by the slightly wider interspaces between them. When it is understood that *Pecten magnificus* lived through from the Miocene to the Recent in warmer latitudes, and that *estrellanus* and its varieties, especially *cerrosensis*, may be but extreme variations of the *magnificus* stock and are at least closely related, it is not so surprising to find a specimen of this form in the warm-water zone of the upper Pleistocene at San Pedro.

Pecten (Lyropecten) arnoldi Aguerrevere

Pecten (*Lyropecten*) *arnoldi* Aguerrevere, Bull. So. Calif. Acad. Sci., Vol. 24, pt. 2, p. 51, pl. 5 (on page 52), 1925.

Type specimen: No. 364 in the type collection at Stanford University.

This species is, so far as the writers know, the largest of all Pectens, the type being 218 mm. long. It is a thick-shelled, equivalved, subcircular species with nine or ten broad, flat ribs and narrower interspaces. There are a few large but rather low secondary riblets which are obscure on the ribs and give the ribs the appearance of being sulcated, but which are stronger in the interspaces, one or more standing above the others like inter-ribs. The ears are large and nearly equal as in *P. jeffersonius;* but the riblets on the ears are coarser, as is typical of *P. magnificus* and its variety *crassicardo.*

This species is known only from the type locality in Venezuela, the horizon being of doubtful Miocene age. Its origin and relationships will be of interest when discovered.

Subgenus **VERTIPECTEN,** new subgenus

Type: Pecten nevadanus Conrad (+ *Pecten bowersi* Arnold).

Shell fairly thick, usually large; strengthened with large radial ribs which are somewhat irregular in number and prominence, showing a tendency to bifurcate or multiply by intercalation, often roughened by imbrication; left valve usually strongly convex, right valve nearly flat; ears on large specimens strengthened by riblets and sometimes imbricated, the right ventral ear being elongate and narrow, separated from the ventral sub-margin by a large byssal notch which leaves behind it a scar as wide as the ear, the ventral submargin strongly concave, the dorsal nearly straight; interior of hinge practically smooth, except for a shallow cartilage pit.

Geologic range: Eocene to middle Miocene (California and Oregon).

The type of this group and its two varieties *fucanus* Dall and *perrini* Arnold have several distinctive characters which clearly separate them from the groups to which they have formerly been assigned. *P. nevadanus* and variety *perrini* have been called *Lyropecten* because of their large heavy shells. The smaller northern variety, on the other hand, was assigned to *Chlamys;* and a more than usually regular specimen of *nevadanus* was assigned to *Patinopecten* under the name of *kernensis* Hertlein. The relationship with *Patinopecten* is the closest, and it is possible that it may be found more convenient to consider *Vertipecten* merely as the ancestral section of *Patinopecten.* However, the size and coarseness of the shells, the irregularity and imbrication of the ribs, and the greater convexity of the left valve compared with the nearly flat condition of the right valve make it seem hardly appropriate to class this peculiar group with *Patinopecten. Vertipecten* is probably derived, like *Lyropecten,* from *Chlamys;* but it is not otherwise related to *Lyropecten,* and the heaviness of the shell gives the two but a superficial resemblance. The irregularity and imbrication of the ribs, the tendency of some of the ribs on the left valve to stand out above the others, and the shape of the elongate right ventral ear, which has an unusually large byssal notch with a scar behind it as broad as the ear, shows the close relationship with *Chlamys;* but again the size and coarseness of the shells, and the unequal convexity of the valves (the right valve, instead of the left as in *Janira,* being nearly flat), and the prominence of the ribs distinguish *Vertipecten.*

Vertipecten appears to be the connecting link between *Chlamys* and *Patinopecten.* Unlike *Lyropecten,* it seems to have been a native of the Pacific coast in the Oligocene. Before the upper Miocene, it gives place to the Patinopectens, and apparently there are no living representatives which have retained its distinctive characters.

It is possible that this subgenus has already received a name in one or more of the New Zealand or Australian publications;[1] but, as is characteristic of the work of the modern school of conchologists in that region, new names are given in such profusion, usually without explanations, references or figures, that it is not worth the effort to try to keep up with them. The present writers do not feel able to identify *Phialopecten*, although the description sounds very much like that of *Vertipecten*. It would, of course, be a matter of very great interest if it should be discovered that *Vertipecten* is the same as *Phialopecten* and that the forms of unknown origin that appeared in the Pliocene of New Zealand really came from the Eocene and Miocene group that split off from *Chlamys* in California. One case like this of migration between California and Australia would, if proven, show that the route between the two places is navigable by at least some kinds of marine mollusks; and such a case would be a blow to the New Zealand and Australian provincialists, as well as to the Californian.

Pecten (Vertipecten) nevadanus Conrad

Plate 7, Figures *2a*, *2b*, *2c*

Pecten nevadanus Conrad, U. S. House of Representatives, Doc. No. 129, p. 19, 1855, reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 171, 1909; U. S. Pacific Railroad Reports, Vol. 5, p. 329, pl. 8, fig. 77, 1856, reprinted by Blake (New York) 1858; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 258 (in part), 1888; Dall, Trans. Wag. Inst. Sci., Phila., Vol. 3, p. 700, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 141, 1906; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 165, 173, 178, 1912.

Pecten (*Lyropecten*) *bowersi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 70, pl. 12, figs. 1, 2, pl. 13, figs. 1, 1*a*, 1906; Proc. U. S. Nat. Mus., Vol. 32, pp. 526, 540, pl. 40, fig. 1, reproduction of type figure, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 147, pl. 27, fig. 1, 1907; Arnold and Anderson, Bull. 322, p. 32, pl. 18, fig. 5, 1907.

Pecten "nevadensis" Conrad, Anderson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 100, 101, 1911.

Pecten bowersi Arnold, Anderson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 100, 1911.

Pecten (*Patinopecten*) *kernensis* Hertlein, Bull. So. Calif. Acad. Sci., Vol. 24, pt. 2, p. 40, pl. 4, fig. 3, 1925.

Shell large, thick-shelled, slightly longer than high, the right valve nearly flat, the left valve rather strongly convex; strengthened with 15 to 18 large, rounded, sometimes slightly flat-topped ribs of variable width, often wider than the interspaces on the right valve and narrower than the interspaces on the left, every third (or fourth) rib on the left valve slightly larger than the others, the interspaces in both valves usually marked by a prominent intercalary, minor radial striation if present at all very faint or irregular and distinctly subordinate to the concentric lamellation which sometimes develops into a spinous imbrication on the tops of the ribs and on the aural riblets, though the ribs in most specimens have been worn smooth and do not show the imbrication plainly; submargins not clearly marked off, sometimes covered with minor ribs, the dorsal submargin nearly straight, the ventral in contrast noticeably concave, probably modified by the pressure of the enormous byssus; hinge line about five-eighths the length of the shell, the ears of nearly equal length, the right ventral slightly longer, abruptly divided longitudinally into two nearly equal parts, the outer part sculptured by about four radiating riblets, the inner part with only concentric lamellation, the lamellation being concave outward toward the byssal notch, which is broadly rounded and about a quarter as deep as the ear is long, other ears rectangularly terminated, with about eight radiating riblets of unequal strength and with concentric imbrication.

Dimensions of neotype: Altitude, 194 mm.; longitude, 200 mm.; length of hinge line about, 125 mm.; convexity of right valve, 20 mm.; of left valve, 45 mm.

The distinctive characters of this species, the peculiar right ventral ear, the nearly flat right valve, the dominance of the concentric lamellation, etc., make it easy to distinguish this peculiar *Pecten* from the Lyropectens related to *Pecten jeffersonius*, with which it occurs. Nearly all of the distinctive characters are shown in Conrad's figure, which illustrates the external mould of the right valve; and they are all described and illustrated by Arnold as belonging to *Pecten bowersi.* Furthermore, as *bowersi* has been reported (by F. M. Anderson) from the type locality of *nevadanus* (Ocoya = Poso Creek, Kern Co.), and as no other species answering to this description has yet been found there, there can now be little doubt that *bowersi* is a synonym of the older name.

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[1] Cf., for instance, "Genus" *Phialopecten* Marwick, Trans. New Zealand Institute, Vol. 58, p. 454, 1927, type (by original designation) *Pecten triphooki* Zittel, Novara Expedition, Geologischer Theil, Vol. 1, Pt. 2, p. 52, pl. 9, fig. 4, 1864. Zittel's figure seems to indicate that *Phialopecten* is quite distinct from *Vertipecten* but the writers have not seen an actual specimen of Zittel's species.

There is in the collection at Stanford University an unusually large, characteristic specimen, well preserved and nearly complete, reported to have come from the lower Miocene of the McKittrick district, but which may have come from the Santa Monica Mountains like the type of *Pecten bowersi.* As Conrad's figure was reproduced from a drawing made in the field, and as the original type was not preserved, this specimen is hereby designated the neotype. It is No. 431 in the Stanford type collection. This specimen was selected in spite of its uncertain locality because its unusually fine illustration of the specific characters appears in this particular case to be a more important consideration. The type of *Pecten bowersi* is in the collection of the University of California, and Arnold's figured paratype is No. 432 in the Stanford type collection. The type of *P. kernensis* is No. 128 in the Stanford collection.

The ribbing in *Pecten nevadanus* is not always so regular as it is in the neotype. Sometimes the ribs are smaller and more numerous and show a tendency to multiply irregularly on the right valve by splitting and on the left valve by the accentuation of some of the intercalaries. Thus, there are specimens illustrating the various stages of gradation into the variety *perrini,* which is the extreme of the series. The variety *fucanus* Dall is an intermediate, somewhat smaller, northern variety. The form described by Hertlein as *kernensis* is a variation with fewer ribs, the right valve resembling the living Japanese *Pecten crassicostatus* Sowerby except that the byssal scar is wider.

The typical variety of *Pecten nevadanus* is known only from the lower and middle Miocene of southern California.

Pecten (Vertipecten) nevadanus Conrad variety **fucanus** Dall

Plate 7, Figures 1*a*, 1*b*

Pecten (Chlamys) fucanus Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 704, pl. 26, fig. 7, 1898; Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 113, 1904, reissued by the Smithsonian Inst., 1910; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 66, pl. 10, figs. 1, 2, 2*a*, 1906.

Like the typical variety but usually somewhat smaller, the ribs on the right valve more often flat-topped and with a greater tendency to bifurcate; also showing a number of sparsely distributed radial striations on both valves.

Type specimen: No. 107,790 in the U. S. National Museum.

This variety is known from the middle Miocene of Washington. Weathering often obscures the minor sculpture.

Pecten (Vertipecten) nevadanus Conrad variety **perrini** Arnold

Pecten (Lyropecten) perrini Arnold, Prof. Paper 47, U. S. Geol. Survey, p. 80, pl. 14, figs. 1, 1*a*, pl. 15, fig. 1, 1906.
Pecten perrini Arnold, Anderson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 100, listed questionably, 1911; Smith, Vol. 3, pp. 165, 173, 178, 1912.

Like the typical variety but with the ribs smaller, more flattened, and more numerous, multiplying by irregular bifurcation on the right valve and by irregular accentuation of the intercalaries on the left; also with more minor radial riblets than is usual in the typical variety.

Type specimen: No. 13 in the type collection at Stanford.

Type locality: Miocene between Moro and Toro Creeks, San Luis Obispo Co.

Variety *perrini* occurs with the typical form.

The ribbing is more irregular in this variety than it is in the variety *fucanus.*

Pecten (Vertipecten) porterensis Weaver

Pecten porterensis Weaver, Wash. Geol. Survey, Bull. No. 15, p. 57, pl. 8, figs. 70, 72, 1912.

? *Pecten (Lyropecten) gabbi* Clark, Univ. Calif. Publ. Geol., Vol. 11, p. 131, pl. 15, figs. 1, 2, 1918, not *Pecten gabbi* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 717, pl. 29, fig. 3, 1898.

Not "*Pecten (Chlamys) porterensis* Weaver" Clark and Arnold, Univ. Calif. Publ. Geol., Vol. 14, pl. 24, fig. 1, 1923; Clark, Vol. 15, p. 83, pl. 11, fig. 1, 1924.

? *Pecten diabloensis* Clark in Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 176, 1924, new name for *Pecten gabbi* Clark, not *Pecten (Lyropecten) diabloensis* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 72, 1906, a distorted specimen of *crassicardo*.

This form is so close to *P. nevadanus* variety *perrini* that the writers cannot tell from the poor specimens figured how to distinguish it. The type specimen of Clark's name is even worse, so that it is difficult to be sure even that it belongs to *Vertipecten*; but the flat right valve and the character of the ribs of the two valves indicate that it probably belongs here, and being of the same age it is questionably referred to Weaver's form. So far, there are no authentic records of a *Lyropecten* in the Oligocene of the Pacific coast, and it is doubtful that Clark's specimen could be a *Lyropecten*. It is true that the illustration resembles somewhat the figure of *Pecten (Lyropecten) vaccamavensis* Olsson[1] from the supposed Miocene of North Carolina, but the true similarity probably ends with the fact that both specimens are very poor. In 1924 Hanna discovered that the name *gabbi* had been preoccupied, and Clark suggested the new name *diabloensis;* but fortunately that name was preoccupied also. It seems better not to try to find another name for it until better specimens are found, when it is hoped that it will be possible to tell whether it is different from *porterensis* and *nevadanus* or not; and at that time a better specimen can be made the type. In the meantime, the forms can be referred questionably to *porterensis*.

Pecten (Vertipecten) ynezianus Arnold

Pecten (Chlamys ?) yneziana Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 8 (separate pagination), (pl. 50, fig. 4 ?), pl. 51, figs. 6*a*, 6*b*, 1907, figures reprinted in Bull. 322 U. S. Geol. Survey, (pl. 12, fig. 4 ?), pl. 13, figs. 6*a*, 6*b*, 1907.

Type specimen: No. 165,313 in the U. S. National Museum.

U. Eocene: Tejon formation of the Santa Ynez Range, Santa Barbara and Ventura counties, California.

This species is much like the others, especially *porterensis*, but shows signs of having been very recently derived from *Chlamys*.

Pecten (? Vertipecten) rhytidus Dall

Pecten (Patinopecten) rhytidus Dall, Nautilus, Vol. 34, p. 76, 1921.

Type specimen: No. 333,044 in the U. S. National Museum.

Type locality: "Pliocene" of Nome, Alaska.

Dall describes this species very inadequately and does not figure it. It has a thick, very heavy right valve of large size and circular shape but of very low convexity, sculptured with 13 or 14 narrow ribs and radial striations. Dall does not mention the ears or left valve, which were probably not preserved. This species can hardly be a *Patinopecten*. The description recalls the type of *kernensis* (= *P. nevadanus*), but it is possible that this species should be referred to the group of *Pecten crassicostatus* Sowerby from Japan.

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[1] *Pecten (Nodopecten) vaccamavensis* Olsson, Bulls. Amer. Paleo., Vol. 5, p. 49 (or Bull. 24, p. 11), pl. 8, fig. 1, 1914.

Subgenus **PATINOPECTEN** Dall, 1898

Patinopecten Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 695, 1898.

Type (by original designation), *Pecten caurinus* Gould.

Shell large, thin, sometimes of a somewhat pearly texture, having a circular outline and very low convexity, valves usually nearly equal, although at times one or the other may become nearly flat; radial sculpture consisting of distinct ribs without minor striation, sometimes with microscopic cross-hatching, ribs of the right valve comparatively broad and squarish, sometimes with a medial sulcus, those of the left valve narrow, often sharp, with intercalaries if the ribs of the right valve are sulcated; hinge line usually short, ears of almost equal length, byssal notch deep in the older species, more shallow in Recent species.

Geologic range: Miocene (possibly Oligocene) to Recent (California).

Distribution: Alaska to Oregon and to Japan.

This group of species, although obviously closely related to *Chlamys* and to *Vertipecten*, is, none the less, a rather distinct unit. It represents an evolutionary adaptation starting in the same direction as that taken by *Amusium;* but the external ribs did not become obsolete, and hence the internal liræ did not become sharp. The general shape, however, is the same. The shape of *Placopecten*[1] is also similar. *Patinopecten* developed distinct external ribs, *Placopecten* retained but faint radial riblets on the exterior, while all that is left of the ribs of *Amusium* are the strengthened internal liræ.[2]

Pecten (Patinopecten) propatulus Conrad

Plate 22, Figure 5

Pecten propatulus Conrad, U. S. Exploring Exped. (Wilkes), Vol. 10, p. 726, Geology Atlas, pl. 18, figs. 13, 13*a*, 1849; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 679, 1864; Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 103, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 258, 1888; ? Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 238, 253, 1916; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 588, 1913; Hertlein and Crickmay, Vol. 68, pp. 260, 267, 1925.

Pecten (*Patinopecten*) *propatulus* Conrad, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 699, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 64, pl. 7, fig. 1 (pl. 9, figs. 1, 1*a*, 2, 2*a*?), 1906; Dall, Prof. Paper 59 U. S. Geol. Survey, p. 112 (pl. 15, figs. 1, 1*a*, 2, 2*a*?), pl. 16, fig. 1 (the same figures), 1909.

Type specimen: No. 3504 in the U. S. National Museum.

Type locality: Miocene, Astoria, Oregon.

M. Miocene: Oregon, Washington, and possibly California, various localities; reports from other horizons at present not to be credited.

The characters of this species have never been satisfactorily described; and as the name is the earliest that has ever been given to a *Patinopecten*, it is necessary to determine its identity before the nomenclature of the other species can be definitely and satisfactorily settled. It is time that the paleontologists of the Northwest give a description and an illustration of a good specimen, and outline the limits of variation of the specific characters so that it will be possible to tell whether *caurinus*, *yessoensis*, or *healeyi* should fall as synonyms or whether it is really different from all of them. The so-called cotypes figured by Arnold and Dall show no characters (except possibly the character of the growth lines) by which they can be distinguished from *P. healeyi*, but it is possible that they are not specifically the same as the holotype, which appears to be a cast not showing the characters well. Conrad describes the species as having 17 ribs (living specimens of *caurinus* have from 16 to 20), and he does not figure nor mention sulcations on the ribs of the right valve, nor interribs between the ribs of the left. It is possible that both *healeyi* and *caurinus* occur in the Miocene of the Northwest, or that one or the other, or both, are found there only in the Coos conglomerate, Pliocene or Pleistocene.

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[1] *Placopecten* Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 69, 1897, type (by original designation) *Pecten clintonius* Say, described in the Journ. Acad. Nat. Sci., Phila., Vol. 4, p. 124, pl. 9, fig. 2, 1824, also described and figured by Verrill, *op. cit.*, p. 78, pl. 17, figs. 1-7, pl. 20, figs. 7, 8, 8*a*, pl. 21, figs. 1, 1*a*, 2, 2*a*, =? *Pecten magellanicus* Gmelin, Miocene to Recent of the Atlantic coast.

[2] *Amusium* is more closely related to *Janira*, and it is probable that its apparent relation to *Patinopecten* is superficial, being a parallel adaptation to a somewhat similar environment.

Pecten (**Patinopecten**) **coosensis** Shumard

Pecten coosensis Shumard, Trans. Acad. Sci., St. Louis, Vol. 1, p. 122, 1858; Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 122, 1868-9; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; Hertlein and Crickmay, Proc. Amer. Phil. Soc., Vol. 64, p. 267, 1925.

Pecten (*Patinopecten*) *coosensis* Shumard, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 700, pl. 26, fig. 2, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 61, pl. 6, fig. 2, pl. 7, figs. 2, 2*a*, 1906; Dall, Prof. Paper 59, p. 112, pl. 16, figs. 2, 2*a*, pl. 17, fig. 3, 1909.

? *Pecten* (*Patinopecten*) cf. *coosensis* Shumard, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 417, 1926.

Shell large, circular, of low convexity, with 27 to 33 strong ribs, those of the right valve narrow, square or T-shaped with sharp angles, and sometimes with faint medial sulcations, those of the left valve more distant and a little rounded.

Dimensions: Altitude, 110 mm.; length, 115 mm.; length of hinge, 54 mm.; diameter of the two valves, 26 mm.

Type locality: Empire formation of Coos Bay, Oregon.

Upper Miocene: Empire formation of Oregon (Shumard, Dall, Arnold, Howe, etc.); Montesano Formation of Washington (Weaver).

? *Pliocene:* Pliocene of Elephant Mesa, Scammon Lagoon Quadrangle, Lower California, questionably identified (Jordan and Hertlein); Coos conglomerate, Coos Bay, Oregon (Howe).

This species is distinguished from *P. purisimaensis* only by its more numerous ribs. As specimens intermediate even in this respect, having 25-27 ribs, were found and noted by Arnold, it is probable that *purisimaensis* is directly derived from *coosensis*.

Variety **coosensis**, s. s.

Ribs without lamellar frills.

Pecten (**Patinopecten**) **coosensis** Shumard variety **dilleri** Dall

Pecten (*Lyropecten*) *dilleri* Dall, Nautilus, Vol. 14, p. 117, 1901.

Pecten (*Patinopecten*) *dilleri* Dall, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 62, pl. 5, fig. 2, 1906; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 431, pl. 30, fig. 1, 1926.

Pecten dilleri Dall, Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 238, 253, 1916.

Shell like that of the typical variety but with numerous prominent lamellar frills on the ribs of both valves.

Type specimen: In the U. S. National Museum, No. 164,846 (?).

Type locality: Lower Pliocene of Rio Dell, Eel River, Humboldt County, northern California.

Lower Pliocene: Type locality, lower Wildcat formation (Martin); also Santa Maria district, middle California (Jordan and Hertlein).

Middle Pliocene: Elephant Mesa, Lower California (Jordan and Hertlein).

It is quite probable that this variety differs from the typical only in the state of preservation. Jordan and Hertlein report the typical form along with *dilleri* from Lower California, and the specimen reported probably is one on which the frills have been worn off. In the older formations of the Northwest where the preservation is not good, it might be expected that the delicate frills would always be destroyed. The fact that the type of *P. purisimaensis* shows traces of the frills, although on most of the ribs the frills have been completely removed, is instructive. It may indicate, since *coosensis* is also a Pliocene species, that *purisimaensis* should be considered another variety of *dilleri*.

Pecten (Patinopecten) purisimaensis Arnold

Plate 6, Figure 3

Pecten (Patinopecten) purisimaensis Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 105, pl. 34, fig. 3, pl. 35, figs. 1, 1*a*, 1906.

Pecten (Patinopecten) turneri Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 106, pl. 34, fig. 4, pl. 35, figs. 2, 3, 1906.

Pecten purismaensis Arnold, Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 243, 253, 1916.

Pecten turneri Arnold, Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922.

Shell like that of *caurinus*, but with 22 to 23 narrower, higher, more sharply angled ribs, ribs sometimes with a slight tendency to be sulcated, and, if not badly worn, with lamellar frills somewhat as on *dilleri*.

Dimensions: Altitude, 125 mm.; length, 125 mm.; length of hinge, 50 mm.; diameter of right valve, 18 mm.; of left, 6 mm.

Type specimens: Of *purisimaensis*, No. 3, of *turneri*, No. 430, in the type collection at Stanford University.

Type localities: Of *purisimaensis*, Pliocene north of the mouth of Pescadero Creek, San Mateo Co.; of *turneri*, Pliocene of Tomales, Marin Co., California.

Pliocene: Merced-Purisima formation, north and south of San Francisco, type localities of the two names.

This species resembles *caurinus* very closely, and is sometimes hard to tell from it. On the other hand, it is very much like *P. coosensis* Shumard, being distinguished principally by its fewer ribs. The lamellar frills, resembling those of *coosensis* variety *dilleri*, emphasize the relationship with that species and suggest that the sharp-angled ribs and the frills go together, the latter in *purisimaensis* having usually been removed by erosion. The type of *P. turneri* is a small, poorly preserved specimen with narrow ribs on which the sulcations are a little stronger than usual.

Pecten (Patinopecten) caurinus Gould

Plate 6, Figure 4

? *Pecten propatulus* Conrad 1849 (see heading for).

Pecten caurinus Gould, Proc. Bost. Soc. Nat. Hist., Vol. 3, p. 345, 1850; U. S. Exploring Exped. (Wilkes), Vol. 12, p. 458, 1852, Mollusca Atlas, pl. 42, figs. 569, 569*a*, 569*b*, 1856; Küster and Kobelt, in Martini-Chemnitz Syst. Conch. Cab., Ser. 2, Vol. 17, Pt. 2, Spondylus und Pecten, p. 152, pl. 43, fig. 1, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 193, 1892; Keep, West American Shells, p. 38, 1904; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, pp. 593, 594, 596, 1913; McLaughlin and Waring, Map Folio accompanying Bull. 69 Calif. St. Mining Bureau, pl. 1, fig. 47, 1914; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 239, 253, 1916.

Pecten heermanni Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 7, p. 267, 1855; not "*Pecten (Lyropecten) heermanni* Conrad," Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 701, 1898, nor "*Pecten heermanni* Conrad" Dall, Nautilus, Vol. 14, p. 117, 1901.

Pecten meekii Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 8, p. 313, December, 1856; U. S. Pacific R. R. Survey, Reports, Vol. 7, p. 190, pl. 1, fig. 1, 1857, the descriptions in these two publications reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, pp. 173, 181, 1909.

Amusium caurinum Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 595, 645, 679, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 81, 131, 165 (bottom pagination), 1872; ? Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 296, 1874; Cooper, Seventh Ann. Rept. Calif. St. Mineralogist, p. 228, 1888; Keep, West Coast Shells, p. 168, 1888, 1892.

Not "*Pecten caurinus* Gould," Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 12, p. 216, pl. 5, fig. 4, 1886, reprinted in Bull. 37 U. S. Nat. Mus., pl. 5, fig. 4, 1889, 1903, = *P. vancouverensis* Whiteaves; ? Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 25, 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 212, 1914.

"*Pecten propatulus* Conrad," Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 258 in part, 1888; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 238, 253, 1916.

Pecten (*Patinopecten*) *caurinus* Gould, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 710, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 107, pl. 13, fig. 6, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 101, pl. 38, figs. 1, 1*a*, 1*b*, pl. 39, figs. 1, 2, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pl. 36, fig. 1, (not p. 25) 1907; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 45, 1916; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 19, pl. 25, fig. 1, pl. 26, fig. 1, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pecten (*Pecten*) *merriami* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 99, pl. 30, figs. 1, 1*a*, 2, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 24, pl. 36, fig. 9 (not a figure of the type), 1907.

Pecten (*Chlamys*) *caurinus* Gould, Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 57, pl. 6, fig. 1, pl. 4, fig. 1, 1924.

Pecten oregonensis Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 98, pl. 11, figs. 1, 2, pl. 12, figs. 1, 2 (all right valves), 1922.

Shell large, thin, of nearly circular outline, valves of very low convexity, sometimes nearly equal, sometimes with the right valve moderately arched and the left valve flat or only slightly convex near the umbo and on large specimens concave beyond; ribs varying from 16 to 20 in number, smooth, on the right valve squarish and equal to or wider than the interspaces, rarely showing a very faint medial sulcus, on the left valve narrow, distant and rounded or triangular, most of the interspaces without inter-ribs, the whole surface of the shell, except where worn, covered with very fine engraved growth lines; hinge line varying considerably in relative length, sometimes half the length of the shell, sometimes nearly three-fifths, ears almost equal in length, not deep, practically without sculpture except for growth lines, byssal notch moderately deep, leaving behind it a distinct scar.

Dimensions: Altitude, 160 mm.; length, 162 mm.; length of hinge, 87 mm.; diameter of right valve, 20 mm.; of left, 5 mm.

Type specimens: Of *caurinus*, No. 5,954, of *meekii*, No. 13,333, in the U. S. National Museum; of *heermanni* in the Academy of Natural Sciences, Philadelphia (*fide* Arnold), not U. S. Nat. Mus. No. 13,317; of *merriami*, probably destroyed in the San Francisco earthquake, a specimen from the Arnold collection of Stanford University having all the characters of *merriami*, and labelled *merriami*, Pliocene of Ventura County, hereby designated the neotype; of *oregonensis*, No. 25 in the Stanford type collection.

Type localities: Of *caurinus*, living, Puget Sound; of *meekii* and *heermanni*, near Santa Barbara, probably uppermost Pliocene; of *merriami*, upper or middle Pliocene of Santa Felicia Canyon, a tributary of Piru Canyon, Ventura County; of *oregonensis*, Empire formation or Coos conglomerate, Coos Bay, Oregon.

? Miocene: Middle Miocene of Oregon and Washington (Carpenter, Dall, Arnold and Hannibal, etc., as *propatulus*); upper Miocene, Empire formation (Howe, as *oregonensis*).

Pliocene: Lower Wildcat formation of northern California (Martin as *propatulus*; Howe as *oregonensis*, etc.); ? middle Pliocene of San Diego (Dall, — the present writers question this occurrence very strongly, the species reported being almost surely *healeyi*); middle or upper Pliocene of Ventura County (Arnold as *merriami*); uppermost Pliocene of Ventura Co., abundant and characteristic, found at locs. 225, 218, 241, etc., S. D. S. N. H. (H. R. G.), and in numerous other places at the top of the Pliocene clay shale; uppermost Pliocene of Santa Barbara (Arnold); Eel River and nearby localities in Humboldt Co., northern California (Arnold); Coos conglomerate of Oregon (Howe); mouth of Raft River, Jefferson Co., Washington (Arnold).

Pleistocene: "Pliocene" and lower San Pedro series of San Pedro and vicinity (Arnold).

Living: Wrangell Island, Alaska, to Siletz Bay, Oregon (Dall); San Pedro (Williamson).

It is unfortunate that the well-known name *caurinus* is threatened by the earlier name *propatulus*, no real attempt ever having been made to separate the two. Dall states that *propatulus* has only 15 ribs, whereas Conrad's original description expressly states that it has 17; and Dall states that *caurinus* has from 20 to 26 ribs, whereas the writers have not noticed in 25 Pliocene and Recent specimens examined a single one with more than 20 ribs (unless the side margins be counted), and the normal number is about 18. Carpenter, whose observations are usually much more accurate than Dall's, considering the scant material he had to work with, makes the following note:

"*Pecten propatulus*, Conr. A very fine specimen, enclosed in a large nodule from Oregon, was presented to the Brit. Mus. by Mr. C. Pace. If not identical with *Amusium caurinum* Gld., it is most closely allied, especially to the Japanese form."

By the Japanese form, Carpenter meant *P. yessoensis* Jay,[1] which he considered a variety of *caurinus;* and there is much to be said for Carpenter's suggestion that *propatulus* may be closely related to *yessoensis*. *P. yessoensis* is distinguished by the fine network sculpture covering the surface of the shell and by its smaller apical angle, which usually causes the shell to be relatively shorter and to have on the average a few less ribs, and which also causes the ears to be deeper. Occasionally *yessoensis* has a mid-rib in one or two of the interspaces of the left valve and a corresponding tendency in the ribs of the right to be slightly grooved; but this irregular feature is also noted in *caurinus*, and the height of the ribs and the width of the interspaces vary as in *caurinus*. Thus, if the form represented by the holotype of *propatulus* has the same minor sculpture that the paratypes (or plesiotypes of *propatulus*) figured by Arnold and Dall have, then *propatulus* is distinguished from *caurinus* by practically the same characters that *yessoensis* is, and the relationship is evident. There are other fossil species of *Patinopecten* in Japan that might help to link the two. Hence, for the time being *caurinus* is considered distinct from *propatulus*, though the separation should not be made on the basis of a misstatement of the number of ribs. There is in the collection at Stanford University a large series of very fine specimens of *caurinus* from the Pliocene or Pleistocene of Eel River, northern California.

Pecten caurinus is a very important and characteristic fossil in the uppermost Pliocene of southern California. Its value lies not in its being confined to the uppermost Pliocene but in its being a characteristically cold-water species. Its abundance in the uppermost Pliocene is indicative of the colder temperatures of the time. It also occurs commonly in southern California in the cold-water horizons of the lower Pleistocene, probably during the glacial periods, and also throughout the Pliocene and possibly in the upper Miocene (Empire formation) of the Northwest. The warmer water species which precedes it in southern California, *P. healeyi*, is distinguished by grooves on the ribs of the right valve and by the inter-ribs which are almost invariably present on the left valve. These two species can be used nearly always in southern California to distinguish the middle Pliocene from the upper, or Santa Barbara, zone.

Pecten (Patinopecten) healeyi Arnold

Plate 6, Figures 2*a*, 2*b*

? *Pecten propatulus* Conrad (see heading for).

Pecten expansus Dall, Proc. U. S. Nat. Mus., Vol. 1, p. 14, 1879; Rivers, Bull. So. Calif. Acad. Sci., Vol. 3, p. 69, 1904; not *Pecten expansus* Smith, Quart. Journ. Geol. Soc., Vol. 3, pp. 413, 419, pl. 18, fig. 21, 1847.

Pecten (Potinopecten) expansus Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 706, pl. 26, fig. 1, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 108, 1903.

Pecten (Patinopecten) healeyi Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 103, pl. 36, figs. 1, 1*a*, pl. 37, figs. 1, 1*a*, 2, 1906, new name for *expansus* Dall; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pl. 34, fig. 1, 1907; Arnold and Anderson, Bull. 322, p. 59, pl. 26, figs. 1, 2, 1907; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 45, 1916; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 417, 1926.

Pecten healeyi Arnold, Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pp. 25, 153, 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, pp. 210, 213, 1914; McLaughlin and Waring, Map Folio accompanying Bull. 69 Calif. St. Mining Bureau, pl. 1, fig. 42, 1914; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 243, 253, 1916; Nomland, Vol. 10, pp. 212, 219, 1917; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

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[1] *Pecten yessoensis* Jay, U. S. Japan Exped., Vol. 2, p. 293, pl. 3, figs. 3, 4, pl. 4, figs. 1, 2, 1856.

? *Pecten yamasakii* Yokoyama, Journ. Fac. Sci., Imper. Univ. Tokyo, Sec. 2, Vol. 1, p. 17, pl. 5, figs. 1, 2, 4, 5, 1925.

? *Pecten tryblium* Yokoyama, Journ. Fac. Sci., Imper. Univ. Tokyo, Sec. 2, Vol. 1, p. 17, pl. 6, figs. 1, 2, pl. 7, figs. 1, 5, 1925.

Shell with the general outline of *caurinus*, usually equivalved, with 17-21 ribs; the ribs of the right valve wider than the interspaces and always distinctly sulcated after the shell has reached a height of about 50 mm., the ribs of the left valve like those of *caurinus*, but after the shell has reached 50 mm., always separated by a strong mid-rib, the interspaces of the right valve often with an obscure mid-rib also; hinge line about half the length of the shell, ears as in *caurinus* except that there are four or five fairly strong radiating riblets on the byssal ear; growth lines as in *caurinus*.

Dimensions (of the rather small figured specimen): Altitude, 85 mm.; length, 86 mm.; length of hinge of right valve, 40 mm.; of left valve, counting the bulge behind the byssus, 45 mm.; convexity of valves, 8 mm. each.

Type specimens: Of *expansus*, No. 7,941, of *healeyi* (designated by Arnold in the explanation of plates), No. 148,012, in the U. S. National Museum.

Type locality: Pliocene of San Diego.

Lower Pliocene: Elsmere Canyon, Los Angeles Co. (Arnold; English), at loc. 206 S. D. S. N. H., Elsmere Canyon, four incomplete specimens (H. R. G.); (? lower) Pliocene of Brea Canyon, 4 miles S. E. of Newhall, Los Angeles Co. (Arnold).

Middle Pliocene: Pacific Beach, San Diego (Dall; Arnold; etc.) common; Tia Juana, Mexico (Greeley in Arnold); Cedros Island, Lower California (Jordan and Hertlein); Temescal Canyon, Santa Monica Mountains, common (Rivers in Arnold); Purisima formation, San Mateo Co., middle California, common (Arnold); occurring commonly in the northern part of Los Angeles County along the outcrop of the middle Pliocene from Newhall tunnel to Pico and Holser canyons, being represented at localities 211-214, 257, 263, 228, 217, etc., S. D. S. N. H. (H. R. G.); doubtfully reported from the "lower" (= middle) Pico of Ventura County (Waterfall).

? *Upper Pliocene:* Fourth and Broadway, Los Angeles (Moody); ? Japan (Yokoyama).

This species is an important horizon marker in southern California, disappearing rather suddenly with the first wave of the colder temperatures of the upper Pliocene, and giving place to *P. caurinus*. Like *caurinus*, the name is threatened by the poorly-known *propatulus*, for both simple-rib and split-rib forms have been identified as *propatulus*. There is nothing to distinguish *healeyi* from the paratypes of *propatulus* illustrated by Arnold and Dall except the microscopic cross-hatched minor sculpture of the latter. *P. healeyi* is distinguished from *caurinus* by the split ribs of the right valve and the intercalaries between the ribs of the left.

Variety **healeyi**, s. s.

Shell usually nearly equivalved, with 17-21 ribs, the sulcations on the ribs of the right valve and the intercalaries on the left valve becoming only moderately strong.

Pecten (**Patinopecten**) **healeyi** Arnold variety **lohri** Hertlein

Plate 6, Figures 1*a*, 1*b*

"*Pecten pabloensis* Conrad," Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 258 in part, 1888.

Pecten (*Patinopecten*) *oweni* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 63, pl. 8, figs. 1, 1*a*, 1*b*, 1906; Arnold and Anderson, Bull. 322 U. S. Geol. Survey, p. 59, pl. 25, figs. 2*a*, 2*b*, 1907; Arnold, Bull. 396, pp. 25, 27, 31, 35, 39, 42, pl. 23, fig. 1, Jan. 15, 1910, repeated in Bull. 398, pl. 45, fig. 1, 1910; not *Pecten oweni* De Gregorio, Naturalista Siciliano, Ann. 3, p. 133, 1884.

Pecten oweni Arnold, English, Univ. Calif. Publ. Geol., Vol. 8, pp. 210, 213, 1914; McLaughlin and Waring, Map Folio accompanying Bull. 69 Calif. St. Mining Bureau, pl. 1, fig. 40, 1914; Nomland, Univ. Calif. Publ. Geol., Vol. 9, pp. 81, 203, 1916; Martin, pp. 232, 243, 245, 253, 1916; Nomland, Vol. 10, pp. 212, 219, 1917.

Pecten (*Patinopecten*) *lohri* Hertlein, Nautilus, Vol. 41, p. 93, January, 1928, new name for *Pecten oweni* Arnold not De Gregorio.

Shell like that of the typical variety but with the right valve more strongly convex and the left usually convex only on the early part, thereafter concave, ribs fewer in number than in the typical variety (14-16), the sulcations on the ribs deeper, and the intercalaries between the ribs on both valves stronger.

Dimensions: Altitude, 95 mm.; length, 100 mm.; length of hinge, 50 mm.; diameter of right valve, 17 mm.; of left valve, 6 mm.

Type specimen: At the University of California.

Type locality: Foxin's, Santa Barbara County, probably Pliocene.

? U. Miocene: Possibly San Pablo formation near Double Eagle wells, Coalinga district, middle California (Arnold); a variety 2 miles south of San Lucas, Monterey Co. (Arnold).

Lower Pliocene: Santa Maria district (Arnold and Anderson); Puente Hills, Los Angeles Co. (Arnold); Elsmere Canyon, Los Angeles Co. (English), localities 209 and 210 S. D. S. N. H., Elsmere Canyon, twenty-three specimens (H. R. G.); locality 227, south of Humphreys Station, Los Angeles Co., three specimens (H. R. G.).

Middle Pliocene: Temescal Canyon, Los Angeles Co. (Arnold); Purisima formation, middle California (Arnold); Merced formation, middle California (Martin).

This variety, as Arnold pointed out, is closely related to the typical variety. The two varieties often occur together, but sometimes the variety *lohri* is more common in older horizons. The upper Miocene occurrences are somewhat doubtful. In the convexity of the valves, *lohri* is similar to the form *merriami* of *caurinus*, which appears to be of no significance. It is the left valve of these forms that is nearly flat, not the right as in the somewhat closely related Vertipectens.

Subgenus **AEQUIPECTEN** Fischer, 1886

Aequipecten Fischer, Man. Conchyl., p. 944, 1886; Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 67, 1897; Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 695, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 49, 1906.

Type (by monotypy), *Ostrea opercularis* Linnæus, living from Norway to the Mediterranean and illustrated in all the principal works dealing with living Pectens, full synonymy and illustrations of variations given by Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 72, pls. 17, 18, 1889.

Shell of moderate size and thickness, of circular outline; ribs uniform, distinct, not bifurcating, sometimes with finely imbricated radial striations; ears usually nearly equal, the byssal notch of moderate depth, ctenolium usually present but small.

Geologic range: Jurassic to Recent.

Distribution: Warm and temperate waters of all oceans.

This subgenus is closely related to *Chlamys*, with which it appears to intergrade; but it can be distinguished by its fewer, more distinct ribs, which are characteristically without striations, by its circular outline, and by its nearly equal ears with a smaller byssal notch. It has representatives in the middle, and possibly in the early Mesozoic, although it is quite probable that it has not kept separate from *Chlamys* during all the time since then but may have been added to by other species of *Chlamys* that have evolved independently into a similar form. In other words, the division may be merely a makeshift one, useful for the present until we know more about the group. It was on one of the *Aequipectens*, *Pecten gibbus* variety *irradians* Lamarck, that Jackson made his most extensive study of the phylogeny of the family.[1]

In 1898 Dall split off the section *Plagioctenium*, describing it as "Resembling *Aequipecten* but without radial striation." The other characters that Dall mentions apply equally well to *Aequipecten, s. s.* In view of the fact that *P. opercularis* is very similar to *Pecten gibbus* variety *irradians* and that *P. purpuratus* and other species assigned to *Plagioctenium* sometimes show the radial striation, it seems somewhat questionable whether *Plagioctenium* should be accorded even sectional value. *Pecten exasperatus* (Linnæus) from Florida has a ventricose form, long hinge line, and fairly strong ribs (characters often cited as distinguishing *Plagioctenium*); but it also has strong radial striation. *Leptopecten* and *Lissopecten* are degenerate forms clearly derived from *Aequipecten*, and should not be given more than sectional rank.

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[1] See above, under the discussion of the *Pectinidæ*.

The subgenus *Aequipecten* has been slighted by California conchologists and paleontologists because Arnold gives as its sole representative *Pecten* (*Aequipecten ?*) *palmeri* Dall,[1] a very peculiar species, the type of which (U. S. N. M. 150,980) looks like the left valve of a very unusual *Chlamys*, having sculpture somewhat like that of the left valve of *hastatus*, but with ears more like those of an *Aequipecten*. The right valve figured by Arnold is probably a specimen of *Leptopecten*, perhaps *tumbezensis* d'Orbigny, the reason for assigning it to *palmeri* not being apparent. On the other hand, several Pacific coast Tertiary species are so close to *P. opercularis* that they can hardly be separated specifically.

Section Aequipecten, s. s.

Valves not very convex, the right one sometimes nearly flat; sculptured with distinct, but low, rounded, usually rather distant ribs, radial striations of variable strength but never very prominent.

Pecten (Aequipecten) pabloensis Conrad

Pecten pabloensis Conrad, U. S. Pacific Railroad Survey, Reports, Vol. 6, p. 71, pl. 3, fig. 14, 1857, description reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 178, 1909; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 258 in part, 1888, Dall, 17th Ann. Rept. U. S. Geol. Survey, p. 844, 1896.
Pecten (*? Plagioctenium*) *pabloensis* Conrad, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 703, 1898.
Pecten (*Plagioctenium*) *pabloensis* Conrad, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 88, pl. 27, figs. 5, 5*a* only, 1906.
Pecten (*Chlamys*) *pabloensis* Conrad, Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 452, pl. 47, fig. 8, pl. 48, fig. 2, 1915.
Pecten (*Plagioctenium*) *bilineatus* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 448, pl. 64, figs. 3, 4, 1915.
Pecten bilineatus Clark, Trask, Univ. Calif. Publ. Geol., Vol. 13, pp. 142, 145, 1922.

Shell rather small, thin, circular, with low, narrow ribs and a suggestion of an intercalary thread, both valves usually somewhat humped up and distorted; internally with strong, sharp radial liræ as in *Amusium;* otherwise like *P. discus*.

Dimensions: Altitude, 30 mm.; length, 31 mm.; length of hinge, 15.5 mm.; convexity of right valve, 4 mm.; of left valve, 5 mm.

Type specimen: At the Academy of Natural Sciences, Philadelphia (?).

Type locality: San Pablo formation, upper Miocene, San Pablo Bay, Contra Costa County, middle California.

Miocene: Alaska (Dall, 1896); upper Miocene, type locality; Briones formation, upper Miocene, of middle California (Trask).

This species appears to be a degenerate offshoot of *P. discus*, with which it occurs and with which it intergrades. The humped-up form may have been caused by the influx of more or less fresh water, and this suggestion is strengthened by the fact that *pabloensis* sometimes occurs very abundantly all by itself in beds two or three feet thick. The writers should probably have considered this form a variety of *discus*, were it not that its name has priority. It is inconvenient to class a normal species under the name of a degenerate variety. Furthermore, the observation noted below made it desirable to keep this form separate.

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[1] *Pecten palmeri* Dall, Nautilus, Vol. 11, p. 85, 1897.
Pecten (*Aequipecten*) *palmeri* Dall, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 136, pl. 50, figs. (2, 2*a*?), 3, 3*a*, 1906.

The most interesting character of *P. pabloensis* is its possession of strong *Amusium*-like internal liræ, which are stronger than the external ribbing, and which cause on internal casts the two lines of *bilineatus*. These liræ are of the same nature as those on the interior of *P. hyalinus* (Poli), which Verrill noted and thought so remarkable that he proposed for that species the new name *Lissopecten*.[1] The writers do not venture to say whether *P. pabloensis* is specifically related to *P. hyalinus* or not; but they take pleasure in noting that this occurrence is a very satisfactory confirmation of Dall's observation that *Lissopecten* is "merely a somewhat degenerate *Aequipecten*." This occurrence also helps to indicate the mode of origin of the internal liræ of *Amusium*. The Pleistocene and Recent *P. hyalinus* of the Mediterranean is well discussed and illustrated by Bucquoy, Dautzenberg, and Dollfus.[2]

Pecten (Aequipecten) discus Conrad

Plate 4, Figure 7

Pecten discus Conrad, U. S. Pacific Railroad Survey, Reports, Vol. 7, p. 190, pl. 3, fig. 1, 1857, description reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 181, 1909; Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 122, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 257, 1888; Calif. St. Mining Bureau, Bull. No. 4, p. 57, pl. 4, figs. 55, 56, 1894.

Pecten (Chlamys ?) discus Conrad, Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 704, 1898.

Pecten (Plagioctenium) discus Conrad, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 86, pl. 27, figs. 1, *1a*, 2, 3, 4, 1906.

"*Pecten (Plagioctenium) pabloensis* Conrad," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 88 in part, pl. 27, figs. 6, *6a*, 7, 1906.

Pecten (Pecten) cierboensis Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 449, pl. 47, fig. 6, 1915.

Pecten (Pecten) raymondi Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 450, pl. 46, figs. 1, 2, pl. 47, figs. 1, 2, 1915.

Pecten raymondi Clark, Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 301, 302, 303, 304, 1917; Trask, Vol. 13, pl. 1, figs. 4, 5, 1922; Kew, Bull. 753 U. S. Geol. Survey, pp. 68-69, 1924.

Pecten (Pecten) raymondi brionianus Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 148, pl. 1, figs. 2, 3, 1922.

Shell of moderate size, outline circular, the valves of very low convexity, the right valve only half as convex as the left; shell sculptured with 17 to 20 low, smooth, rounded ribs of variable width; hinge line variable, about half the length of the shell, ears of nearly equal length, the ventral ears slightly longer, byssal notch moderately deep, narrow, leaving behind it a narrow sunken scar, byssal ear sculptured with three to five moderately strong riblets, other ears with numerous fine weaker riblets.

Dimensions: Altitude, 54 mm.; length, 56 mm.; length of hinge line, 28 mm.; convexity of the right valve, 5 mm.; of the left, 10 mm.

Type specimens: Of *discus*, No. 13,335 in the U. S. National Museum; of *cierboensis*, at the University of California; of *raymondi*, No. 11,581, of *brionianus*, No. 12,368, at the University of California.

Type localities: Of *discus*, between La Purisima and Santa Ynez, Santa Barbara Co., probably from the Monterey formation, middle Miocene; of *cierboensis* and *raymondi*, San Pablo formation, upper Miocene of middle California; of *brionianus*, Briones formation, middle or upper Miocene of middle California.

Middle Miocene: Type locality of *discus;* San Luis Obispo Co. (Arnold), etc.

Upper Miocene: Type localities of *raymondi* and *brionianus;* Santa Margarita formation at its type locality, also north of Coalinga, on the Nacimiento River, and in the Tejon Hills (Nomland); Modelo ? formation, now considered Santa Margarita from hill west of forks in Haskell Canyon and east (= west ?) of Los Angeles reservoir in Dry Canyon, Los Angeles Co. (Kew); common in the basal sandstone beds of the Santa Monica Mts., Los Angeles Co. (Kew); Santa Margarita of well cores in the southern end of the San Joaquin basin (H. R. G.).

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[1] *Lissopecten* Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 68, 1897, type (by original designation) *Ostrea hyalina* Poli; Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, pp. 698, 744, 1898.

[2] Mollusques Marins du Roussillon, Vol. 2, p. 96, pl. 21, figs. 11-17, 1889

This species is so close to *Pecten opercularis* that there can be no reasonable doubt that either the two are descended from the same immediate specific ancestor or that one is derived directly from the other. Indeed, when the group is better known, it may be desirable to put *discus* into the synonymy of *opercularis*, or at least to call it a variety, recognizing in this case as in many others a migration between Europe and California during the Miocene. *P. discus* is distinguished from *opercularis* by the absence (possibly due to the state of preservation) of the delicate radial striations superimposed on the ribs of that species, and perhaps by a slightly deeper byssal notch. There are living varieties of *opercularis* on which the striations amount to little more than color markings.

There has been some question about the application of the name *discus*, and Dr. Clark of the University of California has thought that the name should apply to a middle Miocene species, possibly *andersoni* Arnold, distinct from the upper Miocene form which he called *raymondi*. It is true that *andersoni* and *discus* (as here considered) are very similar and that *andersoni* is difficultly separable on the basis of fewer ribs, smaller size, and narrower byssal ear; but in all these characters (except the last, which Conrad does not mention), the original description agrees better with *discus* as identified by Arnold and by the present writers than it does with *andersoni*. Conrad states that his species has 17 ribs, and is two inches high. In both species the ears are of nearly the same length and the right valves more nearly flat than the left. Conrad's illustration is of no use at all, but Arnold figures the type specimen, or at least what is said to be the type specimen. Furthermore, *discus* was described from shale, and the forms commonly occurring as casts in the middle Miocene shales of the Coast Ranges agree with *discus* as here interpreted, whereas *andersoni* is the ancestor of the living kelp-Pecten and is more characteristic of sandy deposits than shales.

Pecten cierboensis is the young of *P. discus*, being indistinguishable from the young specimen figured by Arnold as *pabloensis* and from the young of living *opercularis*. The apical angle is apt to be smaller and the length of the shell proportionately smaller in young specimens than in old. The form *brionianus* helps to complete the gradation between *andersoni* and *discus*, but is probably not of significance. *P. pabloensis* may be no more than a degenerate offshoot of not more than varietal significance. *P. dallasi* may belong to this group also, being distinguished specifically by its strong radial striations and shorter dorsal ears.

Any attempt to separate the middle Miocene from the upper by means of Pectens of this group is very risky and is more apt to be misleading than helpful. However, *Pecten discus* has never been found in the Pliocene of California and can be used with confidence to distinguish the Miocene from the Pliocene.

Pecten (Aequipecten) weaveri Clark

Pecten (Patinopecten) weaveri Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 454, pl. 45, figs. 1, 2, 1915.

Pecten tolmani Hall and Ambrose, Nautilus, Vol. 30, p. 82, 1916; Trask, Univ. Calif. Publ. Geol., Vol. 13, pp. 142, 146, pl. 3, figs. 1, 2, 1922.

Shell somewhat similar to that of *P. discus*, but usually humped up and distorted, its altitude relatively lower and its 15 to 17 ribs broad, low, and irregular.

Dimensions: Altitude, 67 mm.; longitude, 71 mm.; length of hinge, about 33 mm.; convexity of right valve, 13 mm.

Type specimens: Of *weaveri*, at the University of California; of *tolmani*, No. 23 in the type collection at Stanford University.

Type localities: Of *weaveri*, lower San Pablo formation, near San Pablo Bay, middle California; of *tolmani*, Briones formation, lower San Pablo group, middle California.

U. Miocene: Type localities.

This species is closely related to *P. discus* and to *P. andersoni*, being more nearly like the former in size and the latter in number of ribs. It is possible that all these forms intergrade so that it is not worth while to separate them. *P. weaveri* is a pathologic or brackish water variation of the group, analagous in form and origin to *P. bellus* var. *slevini* Dall and Ochsner. Its chief characteristic is its broad curving ribs and noticeably concave anterior margins (the sides or submargins as usually called).

Section Leptopecten Verrill, 1897

Leptopecten Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 69, 1897.

Type (by original designation), *Pecten monotimeris* Conrad.

Shell thin, small, of low convexity, approximately equivalved (except for the ears); sculptured typically with only a few low, broad folds, but on the older species and on the typical variety of *P. latiauratus* Conrad, where the relation to typical *Aequipecten* is more clearly shown, the folds revealing their true nature as more definite and more numerous ribs; hinge line long, sometimes as long or even longer than the shell, byssal notch deep, with prominent (but delicate) pectinidial teeth.

Geologic range: Miocene to Recent.

Distribution: Warm and temperate latitudes of North and South America.

This section has been treated in various ways by different authors. Dall did not consider it even of sectional significance, for he recognized the characters of *monotimeris* as due entirely to its kelp-inhabiting habits. Some authors have made it a subgenus and have included it in listing the names of species as "*Pecten* (*Leptopecten*)" sp., etc. It has generally been treated as if it belonged to *Chlamys*, whereas it seems rather to be a specialized or degenerate form of *Aequipecten*. It is analogous to *Lissopecten*, and should probably not be accorded even sectional rank. *Pecten andersoni* must be included in it, for it is barely distinguishable from *latiauratus*, and yet *andersoni* may be only a variety of *discus*, which is very close to *opercularis*. Thus the retention of this section makes an artificial separation that obscures the natural facts; and the section is retained here only because the writers do not wish to upset too radically the current usage, preferring in this case to try to explain the usage so that it will not be given too much emphasis.

Pecten (Aequipecten) andersoni Arnold

Plate 4, Figures 4, 5

Pecten (*Plagioctenium*) *andersoni* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 82, pl. 26, figs. 5, 5*a*, 6, 7, 8, 8*a*, 1906.

Pecten (*Plagioctenium*) *andersoni* var. *barkerianus* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 83, pl. 26, fig. 9, 1906.

Pecten andersoni Arnold, Bull. 396 U. S. Geol. Survey, p. 17, pl. 7, fig. 4, Jan. 15, 1910; figure reprinted in Bull. 398, pl. 29, fig. 4, 1910.

? *Pecten* (*Pecten*) *andersoni gonicostus* Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 149, pl. 1, fig. 5, 1922.

"*Pecten* (*Plagioctenium*) *calli* Hertlein," Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 16, in part, not the type, pl. 4, figs. 5, 7, 1925.

Pecten (*Plagioctenium*) *diminutivus* Hertlein and Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 623, 1927, name for the paratype of "*calli*."

Shell like that of *P. discus*, but somewhat smaller, sculptured with only 15 to 16 moderately strong, distant, rounded ribs, ribs of the left valve more triangular, often with a small thread on top.

Dimensions: Altitude, 38 mm.; length, 40 mm.; length of hinge, 23 mm.; convexity of the right valve, 5 mm.; convexity of the left, 7 mm.;

Type specimens: Of *andersoni*, lost (?); of *barkerianus*, at the California Academy of Sciences; of *gonicostus*, No. 12,370 at the University of California; of *diminutivus*, No. 127 in the type collection at Stanford University.

Type localities: of *andersoni*, lower or middle Miocene north of Santa Cruz; of *barkerianus*, middle Miocene of Barker's Ranch, Kern County; of *gonicostus*, upper Miocene, Briones formation, of middle California; of *diminutivus*, Miocene (Temblor ?) west side of Elephant Mesa, Scammons Lagoon Quadrangle, Lower California.

Miocene: Lower, middle, and upper (?) of middle California; middle Miocene of Lower California (Hertlein).

This species is very closely related to *P. discus*, in spite of the fact that it is placed in another section. It is possible that the form *gonicostus* should be referred to *P. discus* instead of to *andersoni*. When small, the ribs of *andersoni* are higher and stronger. *P. andersoni* is also very closely related to the living *latiauratus*, and can only be distinguished by its larger size, stronger ribs, and narrower byssal ear. *P. tumbezensis* is also similar, but has larger ears, the dorsal ears being longer than the ventral, and the shell heavier, though smaller. *P. andersoni* can hardly be used as an index of the lower Miocene, for it must have lived through, giving rise in the upper Miocene or Pliocene to *latiauratus*.

Pecten (Aequipecten) latiauratus Conrad

Pecten latiauratus Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, Pt. 2, p. 238, pl. 18, fig. 9, 1837; Sowerby, Thes. Conch., Vol. 1, p. 57, in part, but not the figures, 1842.

Not "*Pecten latiauritus* Conrad," Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 1, fig. 5, 1852, = var. *monotimeris* Conrad.

Pecten latiauritus Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 645, 1864; Küster and Kobelt, Syst. Conch. Cab., Vol. 17, Pt. 2, Spondylus und Pecten, p. 203, pl. 54, figs. 7, 8, 1888; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 257, 1888; Keep, West Coast Shells, p. 167, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 193, 1892; Keep, West American Shells, p. 40, 1904; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; Kelsey, Trans. San Diego Soc. Nat. Hist., Vol. 1, p. 46, 1907; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 254, 1918; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 564, 1922; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 148, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Pecten (Chlamys) latiauritus Conrad, Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 709, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 111, pl. 12, figs. 2, 2*a*, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 115, pl. 46, figs. 2, 2*a*, 3, 3*a*, 1906; Bull. 309 U. S. Geol. Survey, p. 244, pl. 36, figs. 2, 3, 1907.

Pecten (Chlamys) latiauritus Conrad "var. *monotimeris* Conrad," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 112, pl. 12, figs. 4, 4*a*, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 131, pl. 46, figs. 4, 5, 5*a*, 1906.

Pecten (Chlamys) latiauritus Conrad var. *delosi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 130, pl. 46, figs. 9, 9*a*, 10, 10*a*, 1906, the young.

Pecten (Leptopecten) latiauritus Conrad, Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 3, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 57, pl. 22, fig. 2 (Conrad's type figure), 1924; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 418, 1926.

Shell thin, about 25 mm. in altitude, about as long as high, convexity moderate, the left valve more convex than the right, dorsal extremity somewhat obliquely produced, but usually not so much so as in the variety *monotimeris;* ribs 12 to 16, flat topped and sometimes slightly sulcated, represented on the interior by somewhat angulated grooves, the sides of the ribs, the bottoms of the interspaces, and the ears, especially the early parts and the right ventral ear, marked by strong concentric growth lines; hinge line long, about as long as the shell but variable, the ears sometimes sharp pointed and extended, sometimes not, strengthened by four or five radiating riblets, which are most prominent on the right ventral ear; byssal notch deep, with distinct pectinidial teeth.

Dimensions: Altitude, 25 mm.; longitude, 25 mm.; length of hinge, 21 mm. (often more); convexity of the left valve, 5 mm.; of the right, 3 mm.; umbonal angle, 100°.

Type specimen: Of *delosi*, No. 32 in the type collection at Stanford University.

Type localities: Of *latiauratus*, living, San Diego; of *delosi*, lower San Pedro Pleistocene of Deadman Island, San Pedro Harbor.

Pliocene: Third Street tunnel, Los Angeles (Arnold).

Pleistocene: Basal "Saugus" of locality 244, Sexton Canyon, Ventura Co., two specimens (U. S. G.); middle "Saugus" of locality 249, Ventura, one specimen (U. S. G.); Santa Barbara; San Pedro (Cooper); San Pedro; San Diego (Arnold); San Pedro (T. S. Oldroyd).

Living: Monterey, California, to Lower California (Dall, 1921).

This species is distinguished from *P. bellilamellatus* Arnold by its lower, flat-topped, or somewhat rounded ribs, which are usually more numerous. In the variety *monotimeris* Conrad the ribs become still lower and fewer so that in some specimens they are merely rounded folds and the interspaces are not distinctly separated from the ribs by impressed lines, the hinge line is often shorter, the dorsal extremity of the shell is strongly and obliquely drawn out, and the concentric sculpture is not so distinct. The specimens attributed by Arnold, entirely erroneously, to the variety *monotimeris* have even stronger, higher ribs than the typical form and really belong in the series of variations closer to *P. bellilamellatus.* The specimens here listed from the "Saugus" formation of Ventura County are of this sort. The type specimen of variety *delosi* Arnold is a small specimen with unusually strong concentric lamellation; but since *Pecten bellilamellatus,* which is probably the precursor of this species, has similar lamellation and since the young stages of many specimens of *latiauratus* show strong concentric sculpture, it seems probable that variety *delosi* is merely a young specimen from which the lamellations have not yet been worn off. There are in the Oldroyd collection from the lower San Pedro series of San Pedro several specimens like *latiauratus* in every way except that the ribs are sharper. They are thus closer to *bellilamellatus,* but can still be distinguished by their slightly more numerous, much smaller, and lower ribs. They occur along with normal specimens of *latiauratus,* and it does not seem desirable within such a variable species to give every slightly different form a special name, for these forms are almost surely meaningless, except for showing relationship with *bellilamellatus.*

Mr. E. G. Vanatta, of the Academy of Natural Sciences of Philadelphia, has informed the writers that Conrad's types of *latiauratus* and *monotimeris* cannot be located; but he kindly helped us with the identifications of the true *latiauratus* and *monotimeris,* and it is reasonably certain from a comparison with Conrad's figures and descriptions and with collections that Arnold's identification of *monotimeris* is erroneous.

Pecten (Aequipecten) latiauratus Conrad variety **monotimeris** Conrad

Plate 4, Figures 3, 6

Pecten monotimeris Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, pt. 2, p. 233, pl. 18, fig. 10, 1837; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 645, 1864; Küster and Kobelt, Syst. Conch. Cab., Vol. 17, Pt. 2, Spondylus und Pecten, No. 257, p. 276, pl. 72, figs. 7, 8, 1888; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 257, in part, 1888; Keep, West Coast Shells, p. 167, fig. 140, 1888, 1892.

"*Pecten latiauratus* Conrad" Sowerby, Thes. Conch., Vol. 1, p. 57, pl. 12, figs. 20, 21, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten,* pl. 1, fig. 5, 1852.

Pecten "mesotimeris" Conrad, Sowerby, Thes. Conch., Vol. 1, p. 57, 1842, probably a misspelling for *monotimeris* as indicated by Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 559, 1864.

Pecten tunica Philippi, Abbild. u. Beschreib. Conchyl., Vol. 1, pt. 4, p. 100, pl. 1, fig. 3, 1844, said by Philippi to have come from the Sandwich Islands, but the locality, as explained by Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 574, 645, 1864, is erroneous.

Pecten (Leptopecten) monotimeris Conrad, Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 69, 1897.

Pecten (Chlamys) latiauritus variety *monotimeris* Conrad, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 709, 1898; not Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 112, pl. 12, figs. 4, 4*a*, 1903; Keep, West American Shells, p. 40, fig. 20, 1904; not Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 131, pl. 46, figs. 4, 5, 5*a*, 1906 (see *latiauratus, s. s.*).

Pecten (Chlamys) latiauritus variety *fucicolus* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 710, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 131, pl. 46, figs. 8, 8*a*, 1906.

Pecten (Chlamys) latiauritus Conrad variety *fragilis* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 112, pl. 12, fig. 8, 1903, not *Pecten fragilis* Jeffreys, Ann. and Mag. Nat. Hist., Ser. 4, Vol. 18, p. 424, 1876.

Pecten (Chlamys) latiauritus Conrad variety *cerritensis* Arnold, new name for *fragilis*, Prof. Paper 47 U. S. Geol. Survey, p. 129, pl. 46, figs. 6, 7, 1906.

Pecten (Leptopecten) latiauritus monotimeris Conrad, Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 57, pl. 40, figs. 1, 2, (these figures are not reproductions of Conrad's type figure as stated, but photographs of specimens at Stanford), 1924.

Pecten (Leptopecten) latiauritus fucicolus Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 58, 1924.

Shell thin, about 30 mm. in altitude, about as long as high; convexity moderate, the left valve more convex than the right; dorsal extremity strongly produced obliquely, excess of dorsal half-length over the ventral half-length averaging about 35 per cent but very variable (compare *P. gibbus* var. *circularis*); hinge line long, variable, but usually not so long as the shell; ears shaped and marked like those of the typical variety, the byssal notch and the ctenolium (pectinidial teeth) also similar to those of the typical variety; ribs 7 to 13, low and rounded like folds, often not marked off from the interspaces by distinct lines, the internal grooves of similar character, not angulated; concentric sculpture weaker than in the typical variety, but fine radial striation sometimes visible.

Dimensions: Similar to those of the typical variety, though somewhat larger, as 25:30.

Type specimens: Of *cerritensis*, No. 162,523 in the U. S. National Museum; of *fucicolus*, also in the U. S. National Museum (?).

Type localities: Of *monotimeris*, living, San Diego; of *cerritensis*, upper San Pedro series of San Pedro.

Pleistocene: San Pedro; San Diego (Dall; Arnold).
Living: Monterey, Calif., to the Gulf of California (Dall, 1921).

This variety lives in great abundance attached by its byssus to kelp. Its situs accounts entirely for its special characters. Mrs. I. S. Oldroyd has informed the writers that the normal variety, although not so common, is found attached to worm tubes at low tide level near San Pedro. The forms described by Dall as *fucicolus* and by Arnold as *cerritensis* are but variations of this variety, having a smaller number of ribs. They are almost surely without significance. Intergradations of *monotimeris* with the typical variety are not at all rare.

Pecten (Aequipecten) bellilamellatus Arnold

Pecten (Chlamys) bellilamellatus Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 108, pl. 41, figs. 6, 6*a*, 7, 7*a*, 1906; Proc. U. S. Nat. Mus., Vol. 32, p. 546, pl. 50, fig. 14, 1907.

Pecten (Leptopecten) bellilamellatus Arnold, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 418, 1926.

Shell about 18 mm. in altitude, about as long as high; moderately convex, nearly equivalve; dorsal extremity only slightly obliquely produced (about as much as in *P. gibbus* var. *circularis*); ribs 14 or 15, high, triangular, separated by interspaces about as wide as the bases of the ribs so that the ribs appear widely spaced; the whole surface of the shell sculptured by strong lamellar growth lines; hinge line long, about as long as the shell; ears sculptured with about five radiating riblets, dorsal ears sharply pointed, ventral ears with an arcuate termination, the right ventral set off by a deep byssal notch which bears distinct pectinidial teeth, more strongly sculptured than the others.

Dimensions: Altitude, 18 mm.; longitude, 18 mm.; length of hinge line, 17 mm.; convexity of the two valves, 8 mm.; umbonal angle, 100°.

Type specimen: No. 35 in the Stanford University type collection.

Type locality: Pliocene, Pacific Beach, San Diego.

Pliocene: Pacific Beach, San Diego (Arnold); Cedros Island, etc., Lower California (Jordan and Hertlein).
? *Living:* As *tumbezensis*.

This species is distinguished from *P. latiauratus* Conrad by its slightly smaller size perhaps, but principally by its high, sharply-topped ribs. *P. paucicostatus* Carpenter has fewer ribs and the tops are more broadly rounded.

Pecten (Aequipecten) tumbezensis d'Orbigny

"*Pecten aspersus* Lamarck," Sowerby, Proc. Zool. Soc. London, p. 110, 1835; Thes. Conch., Vol. 1, p. 51, pl. 19, figs. 198, 199, 1842.

Pecten tumbezensis d'Orbigny, Voy. Amer. Mér., p. 663, 1847; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 256, 1909.

Pecten sowerbyi Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 1, species 4, 1852, new name for *aspersus* Sowerby; not *Pecten sowerbyi* Guilding, 1826.

Pecten paucicostatus Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 645, 1864; Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 179, 1865. reprinted in Smithsonian Misc. Coll., No. 252, pp. 100, 131, 281 (bottom pagination), 1872; Küster and Kobelt in Martini-Chemnitz Syst. Conch. Cab., Vol. 17, Pt. 2, Spondylus und Pecten, p. 281, 1888.

"*Pecten* (*Aequipecten*) *palmeri* Dall," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 136 in part, pl. 50, figs. 2, 2*a*, only, 1906.

Pecten (*Plagioctenium*) *paucicostatus* Carpenter, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 137, pl. 39, figs. 3, 3*a*, 4, 1906.

? Pecten (*Chlamys*) *? tumbezensis* Orbigny, Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921.

Shell rather small, heavy, with 13-14 strong ribs, on the right valve rounded and clearly marked off from the interspaces, on the left valve like sharp folds, not marked off; ears large, the dorsal ears larger than the ventral.

Dimensions: Altitude, 35 mm.; length, 37 mm.; hinge line, 25 mm.; convexity of the two valves, 13 mm.

Type specimen: Of *paucicostatus*, No. 15,634*b* in the U. S. National Museum.

Type localities: Of *tumbezensis*, living, Tumbez, Peru; of *paucicostatus*, Gulf of California (*fide* Arnold, the locality originally given being erroneous).

Living: Gulf of California to Peru; ? Santa Barbara, California.

This species is distinguished from *latiauratus* and *andersoni* by its heavier shell and stronger ribs. It is distinguished from *prævalidus* by its lack of radial striations. Young specimens look like *P. bellilamellatus.*

Pecten (Aequipecten) prævalidus Jordan and Hertlein

Pecten (*Leptopecten*) *prævalidus* Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 435, pl. 29, figs. 2, 3, 1926.

Like typical *Pecten latiauratus* Conrad but about twice as large and with distinct radial striation on the ribs and interspaces; ears as in *tumbezensis*.

Type specimen: No. 2,101 at the California Acadmey of Sciences.

Upper Pliocene: S. E. of Turtle Bay, Lower California, common (Jordan and Hertlein).

Section PLAGIOCTENIUM Dall, 1898

Plagioctenium Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 696, 1898.

Type (by original designation), *Pecten ventricosus* Sowerby = *P. gibbus* variety *circularis* Sowerby.

Shell like that of *Aequipecten, s. s.*, but usually with stronger, squarer ribs, on which the radial striations are faint or obsolete; valves often more convex; hinge line long, ears nearly equal.

Geologic range: Oligocene to Recent; in California, upper Miocene or lower Pliocene to Recent.

Distribution: Practically world wide in warm and temperate waters.

Pecten purpuratus and *Pecten gibbus* variety *irradians* each show the intergradation between *Plagioctenium* and the typical section of *Aequipecten*, and they show that the characters of the section are hardly more than of specific significance. *Pecten purpuratus* variety *hakei* grows large and ponderous, so that it might be mistaken for a *Lyropecten;* but it can be recognized as a member of this group not only by its intergradation with typical *purpuratus* but also by the fact that, its ponderosity being newly acquired, the shell did not have time to develop grooves on the interior of the hinge as had the contemporaneous Lyropectens.

The species of the subgenus *Aequipecten,* and especially the Aequipectens belonging to this section, are among the most variable species known. The end forms of such variable species as *Pecten gibbus* Linnæus appear so different that they have been described as distinct, although later, more careful work has shown every gradation between them. Dall (1898) gave a very reasonable treatment of the variations of *Pecten gibbus,* recognizing the geographic extremes as varieties only. Our Pacific coast forms must be treated in the same way, if we wish to avoid the danger of obscuring, for the sake of characters due mainly to the local configuration of the coast line or to local variations in climate, their true relationships and their value for purposes of correlation. A large series of Pacific coast Plagioteniums shows intergradations between most of the forms that have been described as if they were distinct species. They are here arranged into groups somewhat as in Dall's arrangement of the Atlantic forms.

Pecten (Aequipecten) evermanni Jordan and Hertlein

Pecten (Plagioctenium) evermanni Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 439, pl. 27, fig. 1, 1926.

Dimensions: Altitude, 115 mm.; length, 125 mm.; umbonal angle, 108°.

Type specimen: No. 210 at the California Academy of Sciences.

Pliocene: Cedros Island, Lower California, upper Pliocene (Jordan and Hertlein).

This species is closely related to *Pecten purpuratus* variety *hakei* Hertlein, but it appears to be distinct. It is distinguished by its large number (30-31) of flat-topped, very broad ribs, with very narrow interspaces. The convexity of the valves is moderate.

Pecten (Aequipecten) purpuratus Lamarck

Plate 4, Figures 2*a*, 2*b*, 2*c*

Pecten purpuratus Lamarck, Hist. Anim. s. Vert., Vol. 6, pt. 1, p. 166, 1819; Desh. and M. Edw. Ed., Vol. 7, p. 134, 1836; Sowerby, Thes. Conch., Vol. 1, p. 52, pl. 15, fig. 113, pl. 16, figs. 123-125, 1842; Reeve, Conch. Icon., *Pecten,* pl. 5, species 25, 1852; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 149, pl. 26, figs. 5, 6, 1910; Peile in Bosworth, Geol. and Paleo. of N. W. Peru, p. 178, pl. 25, fig. 9, 1922 (MacMillan & Co., London).

Pecten (Plagioctenium) purpuratus Lamarck, Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 14, pl. 1, fig. 1, pl. 4, figs. 2, 4, 1925; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 442, 1926.

Shell of moderate to large size, usually of low convexity, with the left valve always the more convex, outline circular or with slight obliquity, with a comparatively large apical angle, weight of shell variable among the different varieties, sculpture consisting of 19 to 26 radiating ribs, the height and angularity of which vary roughly with the weight of the shell; hinge line more than half the length of shell, byssal ear with about five fairly strong radiating riblets, the other ears with seven or eight finer riblets, dorsal ears nearly square on the end, the left ventral ear gently arcuate, the right ventral strongly arcuate with a fairly deep byssal notch, the whole surface of the valves including the ears covered with fine growth-line lamellæ which are sometimes prominent as fringes along the sides of the ribs.

Dimensions: Altitude, 105 mm.; longitude, 120 mm.; length of hinge, 70 mm.; convexity of the two valves, 40 mm., of which about 27 mm. are in the left valve; umbonal angle, 118° .

Pecten purpuratus represents a very variable group of forms, some of the varieties of which bear a striking resemblance to corresponding variations of *Pecten eboreus* Conrad of the Atlantic coast. The group as a whole in practically all cases is distinguishable from

Pecten gibbus and its varieties by the much lower convexity of the valves, by the fact that the left valve instead of the right is always the more convex, by a greater average number of ribs, and by the greater size of the adult in all cases except in variety *mendenhalli*, which is quite possibly the young of one or more of the others. The varieties of *Pecten deserti* are intermediate forms with nearly equal convexity of valves, a smaller size and a smaller average number of ribs than *purpuratus*, and (except in the distorted type variety *deserti*) with a greater ratio of altitude to length.

The variations of the different characters may be summarized as follows: The umbonal angle, though not at all constant within the varieties themselves, is noticed to be slightly larger in varieties *percarus*, *purpuratus*, and *hakei* than in varieties *mendenhalli*, *cristobalensis*, *callidus*, or *subdolus*. The extremes are *percarus* and *subdolus*, but there are specimens of *percarus* which have as small an angle as the type of *subdolus*. The dorsal extremities of varieties *percarus* and *subdolus*, and to a less extent those of *callidus* and *cristobalensis*, show a strong tendency to be drawn out obliquely, whereas in the other variaties the valves are less inequilateral. The ribs of the right valve vary from the broad, moderately high ribs on typical *purpuratus* to high, narrow, squarish ribs on extreme specimens of *cristobalensis*, and to low rounded ones on *percarus* and *subdolus*. The ribs of typical *purpuratus* and also of variety *cristobalensis* appear in the living specimens abnormally wide because of the lateral fringes (see the quotation from Dall on the varieties of *Pecten gibbus*); so that in comparing them with fossils on which the fringes have been worn off, allowance must be made for the difference. The shell of typical *purpuratus* is moderately thick, that of variety *hakei* is thicker, that of *percarus* and *subdolus* thinner. The convexity of *percarus* is slightly less than that of other varieties, though the convexity of each variety varies considerably. The relative length of hinge line is slightly less in the type specimens of *subdolus*, *callidus*, and *percarus*, and in some specimens of *mendenhalli*. Also, in varieties *subdolus*, *callidus*, and sometimes *mendenhalli*, the ratio of altitude to length is greater than in the other forms, though this character is rather a function of the umbonal angle than a distinct feature. The ears vary in the number and strength of striations, though preserving on the whole a similar general appearance.

Thus there is represented within this species a long list of variable characters, to which others probably could be added. The number of possible combinations of these characters is practically unlimited. With every new collection new combinations appear, forms with half the characteristics and perhaps the general appearance of one variety, but with other important characteristics of a second. There are intergradations between the extremes of all the characters; and by selecting different features as ultimate criteria, the specimens of a collection may be assigned to the different varieties in many different ways. The whole group cannot be arranged satisfactorily in a linear series, but had better be thought of as a spherical aggregate with typical *purpuratus* (fortunately) in the center and variations outward in every direction, there being lateral intergradations as well between the various radiating series. All of the varieties so far described have been found at a single locality at Cedros Island, Lower California, and many of them have been found together in a limited horizon in the Santa Clara Valley of southern California, hundreds of miles from Cedros Island. Typical *purpuratus* and variety *cristobalensis* are found living off the coast of Peru today, and the latter is labeled in the Oldroyd Collection at Stanford University, "color form." It may be only a question of time before others of the group are found living in southern waters. With these records under consideration and with a realization of the great variability generally exhibited by other strong or dominant species, it seems as if it would greatly obscure the scientific facts of the case and lessen the value of this common group for purposes of correlation to separate the variations artificially into distinct species. The names already proposed are here retained as varieties of the earliest described form, which happens to represent very nearly the average of their properties; for it is not thought desirable to destroy whatever possible value, if any, may later be found in such separations, and in general practice not much stress is laid upon the importance of varietal distinctions. There are in the collections several forms which do not agree closely with any of the previously described varieties, and might, as Davenport says of his Cold Spring Harbor form-unit of *Pecten gibbus*, "receive a new varietal name, were not the futility of this endless naming, alas, too evident."

Variety **purpuratus,** s. s.

Pliocene: Lower California (Hertlein; Jordan and Hertlein); Pico formation near the Los Angeles Reservoir, San Fernando, one specimen (Stanford collection).

Pleistocene: Tablazos beds of N. W. Peru (Peile).

Living: Coquimbo, Chile, northward to Ecuador (Dall, 1910).

The typical variety is distinguished by its large umbonal angle, moderate thickness of shell, moderate convexity, comparatively wide but only moderately high ribs with conspicuous lateral fringes, length greater than altitude, hinge line more than half the length of the valves, and obliquity scarcely noticeable. The ribs of the right valve are equal to or a little wider than the interspaces; those of the left valve are narrower than the interspaces. Ribs 22 to 25.

Pecten (Aequipecten) purpuratus Lamarck variety **hakei** Hertlein

Plate 8, Figure 3

Pecten (*Plagioctenium*) *hakei* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 18, pl. 4, figs. 1, 3, 1925.

Dimensions: Altitude, 115 mm.; longitude, 135 mm.; length of hinge, 90 mm.; convexity of two valves, 57 mm.; umbonal angle, 110-120°.

Type specimen: No. 40 in the type collection at Stanford University.

Type locality: Pliocene of Turtle Bay, Lower California.

Pliocene: Lower California (Hertlein); San Diego formation, San Diego (Hertlein and Grant); 1½ miles west of Somis, Ventura Co., "Saugus" formation (Stanford collection).

This variety is characterized by a larger, heavier, thicker shell than the typical form, and the ribs are somewhat more rounded and less definite. The convexity of the valves varies greatly. This variety bears all the ear-marks of a gerontic type which in old age thickened its shell and deposited material less regularly and less delicately than it did in its young and mature stages.

The opinion that *hakei* is the gerontic stage of variety *purpuratus* or *cristobalensis* is strengthened by the fact that the older specimens of these two varieties grade perfectly into the smaller specimens of *hakei*, and also by the fact that there are no young specimens of *hakei* in the collection. If similar gerontic forms should be found living, the name had better be discarded; but the name is retained here in case larger collections should show that no living individuals grow so large, for the size might then have some significance. In the latter case some of the Pliocene records from Lower California of either *purpuratus* or *cristobalensis* or both should be included under this variety. Ribs 22 to 26.

Pecten (**Aequipecten**) **purpuratus** Lamarck variety **cristobalensis** Hertlein

Plate 5, Figure 2

Pecten (*Plagioctenium*) *cristobalensis* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 19, pl. 3, figs. 1, 2, 5, 1925; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 439, 1926.

Dimensions: Altitude, 85 mm.; length, 90 mm.; length of hinge, 52 mm.; convexity of the two valves, 35 mm.

Type specimen: No. 36 in the type collection at Stanford University, herewith figured.

Type locality: Uppermost beds, slopes of Salada, S. E. of Turtle Bay, San Cristobal Bay Quadrangle, Lower California.

Pliocene: Lower California (Hertlein; Jordan and Hertlein); locality 217*b*, middle Pico of Holser Canyon, Los Angeles Co., one specimen doubtfully referred to this variety (H. R. G.), similarly, locality 217*a*, two specimens (H. R. G.), locality 214, middle Pico west of Fernando Pass, Los Angeles Co., one specimen very doubtful (H. R. G.).
Living: Coast of Peru (Oldroyd collection).

This variety is characterized by stronger sculpture; the ribs are narrower and higher and of sharper outline than on the typical variety. Without the fringes the ribs are narrower than the interspaces even on the right valve. The type specimen itself, however has more rounded ribs, looking much as a young *hakei* should look. The "color form" in the Oldroyd Collection at Stanford University is pinkish in color, whereas the typical form is more often purple. Ribs 20 to 24.

Pecten (**Aequipecten**) **purpuratus** Lamarck variety **percarus** Hertlein

Pecten (*Aequipecten*) *percarus* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 13, pl. 2, figs. 2, 5, 1925; Jordan and Hertlein, Vol. 15, p. 435, 1926.

Dimensions: Altitude, 81 mm.; longitude, 90 mm.; length of hinge, 48 mm.; convexity of the two valves, 24 mm.; umbonal angle, 121°.

Type specimen: No. 42 in the type collection at Stanford University. The "holotype" of *percarus* does not consist of matched valves, for the right has 20 ribs and the left 25. Therefore the two valves should be called cotypes.

Type locality: Mouth of big arroyo N. W. of Elephant Mesa, Scammons Lagoon, Lower California.

Pliocene: Lower California (Hertlein; Jordan and Hertlein); middle Pico of locality 214, one specimen, and of locality 211, three specimens, west of Fernando Pass, Los Angeles Co., (H. R. G.); ? Pliocene of the Waccamaw beds, South Carolina, as *senescens* (Dall), (if the two forms should be the same, this name of course has priority).

This variety is distinguished by its low, rounded ribs, thinner shell, low convexity, large umbonal angle, and (in the type) short hinge line. In some respects this variety is the most definite of all, although there are intergrades with the less characteristic specimens of *cristobalensis*, and there is some question about the advisability of trying to separate it from the variety *subdolus*. It usually (but not always) has a larger umbonal angle than *subdolus*, and the ratio of altitude to length is smaller. Sometimes also the hinge line is longer than is normal for *subdolus*. So far as can be told from the figure and description, this variety is indistinguishable from *Pecten eboreus* Conrad variety *senescens* Dall (Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 751, pl. 29, fig. 5, 1898); but no specimens have been available for comparison. Ribs 20 to 25.

Pecten (Aequipecten) purpuratus Lamarck variety **subdolus** Hertlein

Plate 5, Figure 1

"*Pecten* (*Plagioctenium*) *cerrosensis* Gabb," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 123, pl. 49, figs. 1, 1*a*, 1*b*, 1906, in part; Bull. 309 U. S. Geol. Survey, p. 24, pl. 35, fig. 6, 1907, in part.

Pecten (*Plagioctenium*) *subdolus* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 20, pl. 5, figs. 2, 4, 7, 1925; Jordan and Hertlein, Vol. 15, p. 443, 1926.

Dimensions (of large specimen): Altitude, 110 mm.; longitude, 110 mm.; length of hinge, 65 mm.; convexity of the two valves, 30 mm.; umbonal angle, 105°. Dimensions of the type: Altitude, 49 mm.; longitude, 50 mm.; length of hinge, 21 mm.; convexity, 18 mm.; umbonal angle, 108°. Arnold records a specimen 200 mm. long. A specimen from San Diego had an umbonal angle of only 100°.

Type specimen: No. 51 in the type collection at Stanford University.

Type locality: Pliocene of Pacific Beach, San Diego.

Pliocene: Cedros Island, Lower California (Arnold); Cedros Island and Turtle Bay, Lower California (Hertlein; Jordan and Hertlein); San Diego (Hertlein; Jordan and Hertlein; Hertlein and Grant); middle Pico of locality 211, west of Fernando Pass, Los Angeles County, two specimens (H. R. G.); also locality 214, one specimen which might equally well have been referred to *callidus* (H. R. G.).

This variety is distinguished by low, rounded ribs with wide interspaces, and by short hinge line and small umbonal angle. Consequently, the ratio of altitude to length is larger, being usually nearly one to one. This variety is very like *percarus* in sculpture and *callidus* in shape. Ribs 20 to 22.

Arnold listed *Pecten* (*Plagioctenium*) *subventricosus* Dall as a synonym of this form, and if he were correct Dall's name should of course be used. However, Mr. Mansfield of the U. S. National Museum has informed the writers that Dall's type is close to *Pecten gibbus* var. *circularis* Sowerby.

Pecten (Aequipecten) purpuratus Lamarck variety **callidus** Hertlein

Plate 5, Figure 4

"*Pecten* (*Plagioctenium*) *cerrosensis* Gabb, square ribbed variety," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 124, 1906.

Pecten (*Plagioctenium*) *callidus* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 22, pl. 5, figs. 1, 3, 5, 6, 1925; Jordan and Hertlein, Vol. 15, p. 437, 1926.

Dimensions: Altitude, 54 mm.; longitude, 55 mm.; length of hinge, 29 mm.; convexity of the two valves, 19 mm.; umbonal angle, 107°.

Type specimen: No. 53 in the type collection at Stanford University.

Type locality: Pliocene of Cedros Island, Lower California.

Pliocene: Lower California (Hertlein; Jordan and Hertlein); San Fernando (Arnold); San Diego (Stanford collection); middle Pico of locality 211, one specimen, of 212, one, of 213, two, and of 214, six, all west of Fernando Pass, Los Angeles Co. A few of these specimens are typical, but most of them are intermediate between this and other varieties.

This variety is characterized by high, moderately wide, square ribs, like those of *cristobalensis* but not so extreme. The hinge line is shorter and the umbonal angle smaller than in *cristobalensis*, and the ratio of altitude to length is about one. Arnold records a specimen over 100 mm. in altitude, but usually *callidus* is smaller than the other varieties (with the exception of *mendenhalli*). It is like *subdolus* with stronger sculpture. Ribs about 20.

Pecten (Aequipecten) purpuratus Lamarck variety **mendenhalli** Arnold

Pecten (*Plagioctenium*) *cerrosensis* Gabb variety *mendenhalli* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 84, pl. 25, figs. 2, 2*a*, 2*b*, 1906.

Not "*Pecten* (*Plagioctenium*) *cerrosensis mendenhalli* Arnold," Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 16, pl. 1, fig. 5, 1925 (= *Pecten gibbus* var. *demiurgus* Dall ?).

Pecten mendenhalli Arnold, Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 473, pl. 25, figs. 4, 5, 1926.

Not "*Pecten* (*Plagioctenium*) *mendenhalli* Arnold" Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 442, 1926, but the authors in this reference show why *mendenhalli* is not a variety of *cerrosensis* Gabb.

Dimensions: Altitude, 40 mm.; longitude, 44 mm. (or proportionally less in some specimens); length of hinge, 29 mm. (or less); convexity of the two valves, 16 mm.; umbonal angle, 110° (or 105°).

Type specimen: No. 164,849 in the U. S. National Museum.

Type locality: Pliocene of Santa Rosalia, Lower California.

Pliocene: Santa Rosalia, Lower California; Garnet and Alverson canyons just north of the Mexican boundary, San Diego Co., Calif. (Arnold); Coyote Mt., Imperial Co., Calif. (Hanna); Cedros Island, Lower Calif. (Hertlein, oral communication); middle Pico of locality 214, west of Fernando Pass, Los Angeles County, three specimens with rounded ribs and prominent lamellation, probably belonging here (H. R. G.).

This variety is characterized by rather wide but low, squarish or rounded ribs and small size. The hinge line and apical angle vary considerably. More careful work may show that this form is just the young of typical *purpuratus* or of one of the later named varieties. It is difficult to distinguish from any of them. Ribs 19 or 20.

Pecten (Aequipecten) deserti Conrad

Plate 5, Figure 3

Pecten deserti Conrad, "Descr. Fos. and Rec. Shells," U. S. House of Representatives Doc. 129, p. 15, July, 1855; U. S. Pacific Railroad Survey Reports, Vol. 5, p. 325, pl. 5, fig. 41, 1856; Conrad's descriptions reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, pp. 167, 181, 1909; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 257, 1888; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 232, pl. 6, figs. 1, 1*a*, 1*b*, 1917; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 470, pl. 25, figs. 1, 2, 3, 1926.

Pecten (*Plagioctenium*) *deserti* Conrad, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 703, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 85, pl. 26, figs. 1, 2, 2*a*, 3, 4, 4*a*, 1906.

Shell of small or moderate size, noticeably higher than wide and of low convexity except in the distorted type variety, valves almost equally convex; ribs small, low, and rounded, or high, wide, and square, varying in number from 15 to 19.

The group of forms included here is intermediate between the *Pecten purpuratus* group and the *Pecten gibbus* group. It probably represents a derivative or a branch of the *purpuratus* stock which was able to adapt itself to more rigorous living conditions, for it is found farther northward and in the probably slightly brackish water deposits at the head of the Pliocene Gulf of California and in the San Joaquin basin. It is unfortunate that the earliest described member of this group is the distorted, probably brackish water variety from the Coyote Mt. region; for although it is not typical, it must be called the type variety. The normal marine form is described as *invalidus* Hanna (new name for *cooperi* Arnold), and except for the rules of nomenclature *invalidus* should be the species name and *deserti* the specialized variety. The *Pecten gibbus* stock including the common Pacific coast variety *circularis* probably represents a later wave of migration from a common center or metropolis. The *deserti* group, however, is more closely linked by intergrading series with *Pecten purpuratus*, and it is possible that the two should be classed together as has been done apparently with the Atlantic coast varieties of *Pecten eboreus* Conrad, which seem to include representatives of both. Hanna says in reference to three forms typical of these three groups: "The species *circularis*, *deserti*, and *mendenhalli* are undoubtedly very closely related. With a large series of specimens from different places, it is possible all would be found to constitute an intergrading series, but at present some of the connecting links seem to be absent." It is true that we have now the intergradation between *mendenhalli* and *deserti*, and in other parts of this hemisphere there are similar intergradations between the *deserti* type and the *circularis* or *gibbus* type. Nevertheless, the three groups appear to have a distributional and perhaps a stratigraphic significance; and in any case, *Pecten purpuratus*, a clearly characterized species close to the typical Aequipectens, should be specifically separated from *Pecten gibbus*, of which the variety *circularis* is the type of Dall's section *Plagioctenium*.

Pecten deserti and its varieties are distinguished from *Pecten purpuratus* by the equal convexity of the valves, the fewer ribs, the greater ratio of altitude to length, the smaller size, etc. From *Pecten gibbus* and its varieties they are distinguished by the equal and normally lower convexity of the valves, and in some cases by the fewer ribs.

Variety **deserti**, s. s.

Dimensions: Altitude, 32 mm.; longitude, 32 mm.; length of hinge, 22 mm.; convexity of the two valves, 25 mm.; umbonal angle varying from 90° to 105°. Sometimes the longitude is 4 or 5 mm. greater or less than the altitude.

Type specimen: No. 8398 in the U. S. National Museum.

Pliocene: Coyote Mt., Imperial Co. (Conrad; Arnold; Hanna; etc.).

The specimens of this variety nearly all have a somewhat distorted appearance. The young specimens are very convex, but most of them when about half grown flatten out noticeably, giving the whole a fanciful resemblance to the ruffled-up neck of a pigeon. A few less distorted specimens, however, show the relationship of this variety to the more normal, moderately convex varieties. *Pecten eldridgei* Arnold, from the Pliocene of the southern San Joaquin basin, is a distorted, specialized, probably also brackish water form even more peculiar than *deserti*. It is characterized by a small, very thick shell that is so buckled up that the two valves when put together are almost spherical or nut-like in shape.

This variety is abnormally convex for the species. It is distinguished by the convexity, by the close-set, fairly small ribs of the right valve which are roughly rounded, with narrow flattened tops, by the roughly triangular ribs of the left valve, and by the distorted appearance. The outline is very inconstant, the shell being elongated sometimes in the direction parallel to, sometimes in the direction perpendicular to the hinge. Ribs usually 18 or 19.

Pecten (Aequipecten) deserti Conrad variety **invalidus** Hanna

Plate 5, Figures *5a*, *5b*, *5c*, *6a*, *6b*, *6c*

Pecten (*Plagioctenium*) *cooperi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 124, pl. 49, figs. 2, 3, 4, 1906, not *Pecten cooperi* E. A. Smith, Fauna and Geography of the Maldive and Laccadive Archipelagos, Vol. 2, p. 621, 1903.

Pecten invalidus Hanna, new name for *Pecten cooperi* Arnold, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 177 top, 1924.

Pecten (*Plagioctenium*) *invalidus* Hanna, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 441, 1926, in part (?).

Dimensions of type: Altitude, 35 mm.; longitude, 37 mm.; length of hinge, 22 mm.; convexity of the two valves, 16 mm.; umbonal angle, 105°. Dimensions of figured specimen (plate 5, figures 5): Altitude, 40 mm.; longitude, 39 mm.; length of hinge, 26 mm.; convexity of the two valves, 18 mm.; umbonal angle, 95°.

Type specimen: No. 8 in the Stanford University type collection.

Type locality: Pliocene of Pacific Beach, San Diego.

Pliocene: Pacific Beach, San Diego (Arnold; Hertlein and Grant); middle Pico of locality 211, one specimen. of 213, two, of 214, two, west of Fernando Pass, Los Angeles Co. (H. R. G.); middle Pico of locality 217, six specimens, of 217*a*, fourteen, of 217*b*, six, Holser Canyon, Los Angeles Co. (H. R. G.),

This variety is distinguished by its moderate convexity, square, high ribs, which are sometimes considerably wider than the interspaces on the right valve, small umbonal angle and consequently larger ratio of altitude to length. It is very close to specimens of *Pecten eboreus* Conrad var. ? in the Stanford University collection, from the Pliocene Caloosahatchie marls of Florida. Ribs 16-19.

Pecten (Aequipecten) deserti Conrad variety **impostor** Hanna

Pecten deserti Conrad, Arnold, Bull. 396 U. S. Geol. Survey, p. 76, pl. 26, figs. 3, 4, Jan. 15, 1910, reprinted in Bull. 398, pl. 48, figs. 3, 4, 1910.

Pecten proteus Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 232, pl. 6, figs. 2, 2*a*, 2*b*, 2*c*, 1917, not *Pecten proteus* Sowerby, Thes. Conch. p. 59, pl. 13, figs. 53, 54, 1847.

Pecten impostor Hanna, new name for *Pecten proteus* Nomland, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 177 middle, 1924.

Dimensions: Altitude, 44 mm.; longitude, 42 mm.; length of hinge, 25 mm.; convexity, 18 mm.; umbonal angle, 90-95°.

Type specimen: No. 11,089 at the University of California.

Type locality: Pecten coalingensis zone, Etchegoin middle Pliocene of the Coalinga district, middle California (Nomland).

Pliocene: Type locality; middle Pico of locality 211, three specimens, of locality 214, five, west of Fernando Pass, Los Angeles Co. (H. R. G.); middle Pico of locality 217, three, of 217*a*, seven, of 217*b*, five, Holser Canyon, Los Angeles Co. (H. R. G.).

This variety is characterized by low convexity, low, roughly rounded ribs, with a very variable outline. Often the umbonal angle is unusually small and likewise the ratio of altitude to length. Some of the shells are conspicuously oblique. Ribs 18 to 20.

Pecten (Aequipecten) eldridgei Arnold

Pecten (*Plagioctenium*) *eldridgei* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 87, pl. 25, figs. 3, 3*a*, 3*b*, 4, 4*a*, 5, 5*a*, 6, 1906.

Pecten eldridgei Arnold, Pack, Prof. Paper 116 U. S. Geol. Survey, p. 35, 1920.

Shell small, both valves very convex, thickened, sculptured with 19 to 20 low, squarish ribs.

Dimensions (from Arnold): Altitude, 20 mm.; longitude, 21 mm.; length of hinge, 15 mm.; diameter of the two valves, 15 mm.

Type specimen: In the U. S. National Museum, No. 164,850.

Type locality: In the hills south of Dabney water wells, McKittrick district, Kern County, "upper Miocene."

Pliocene: Etchegoin formation of the southeastern end of the San Joaquin basin, at the type locality (Arnold), and between McKittrick and Midway (Pack).

The original reference of this species to the Miocene created an enigma, for the species from which it is most likely to have been derived, *deserti* and *circularis*, are not known so far north as California in the Miocene. Pack, however, has identified it in Etchegoin beds not far from the type locality; and it is probable that the type locality also is Etchegoin. *P. eldridgei* appears to be a stunted, brackish-water derivative of *deserti*, most like the typical form; and it is not at all surprising to find it in beds that are approximately equivalent in age to the beds in which the varieties of *deserti* are found. Even the typical variety of *deserti*, from the Imperial formation, may be of approximately equivalent age.

Pecten (Aequipecten) gibbus (Linnæus)

Ostrea gibba Linnæus, Syst. Nat., Ed. 10, p. 698, 1758; ? Born, Test. Vindo., p. 107, 1780.

Pecten dislocatus Say, Journ. Acad. Nat. Sci., Phila., Vol. 2, p. 260, 1822; American Conchologist, pl. 56, figs. 2, 2*a*, 1834; Holmes, Post-Pliocene Fos. of So. Carolina, p. 13, pl. 2, fig. 13, 1858.

Pecten soverbii Guilding, 1826 (not of Reeve 1852).

"*Pecten purpuratus* Lamarck" Conrad, Amer. Marine Conch., p. 10, pl. 2, fig. 1, 1831; DeKay, Zool., N. Y., Vol. 5, p. 174, 1843.

Pecten gibbus Linnæus, Sowerby, Thes. Conch., Vol. 1, fig. 17 (only), 1843; d'Orbigny, Moll. Cuba, Vol. 2, p. 352, 1845; Reeve, Conch. Icon., *Pecten*, pl. 9, figs. 37*b*, 37*c*, not 37*a*, 1852; Krebs, West Indies Mar. Sh., p. 134, 1864; Arango, Fauna Mal. Cubana, Vol. 2, p. 270, 1878; Davenport, Mark Anniversary Volume, pp. 123-136, pl. 9, 1903.

"*Pecten circularis* Sowerby," Guppy, Paria Fauna, p. 155, 1877.

"*Pecten nucleus* Born," Heilprin, Trans. Wagner Inst. Sci., Phila., Vol. 1, p. 102, 1886.

Pecten irradians var. *dislocatus* Say, Dall, Bull. 37 U. S. Nat. Mus., p. 34, 1889.

Pecten (*Plagioctenium*) *gibbus* Linnæus, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 745, 1898; Maury, Bulls. Amer. Paleontology, No. 34, p. 27, 1920; No. 42, p. 86, pl. 14, fig. 2, pl. 16, fig. 1, 1925.

Pecten (*Plagioctenium*) *gibbus* var. *dislocatus* Say, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 746, 1898.

The group of closely related intergrading forms here classified under the name of *Pecten gibbus* is characterized by shells of moderate size and thickness, usually of strong convexity, the right valve noticeably more convex than the left, the outline nearly circular but with the dorsal margins more or less obliquely drawn out; sculptured by ribs averaging for the whole group 19 or 20 in number, with moderate height and often a tendency to be flattened on top, equal to or wider than the interspaces; hinge line more than half as long as the shell; ears sculptured by radiating lines of varying strength, four to six fairly strong ridges on the right ventral ear, on the other ears a varying number of finer lines which sometimes cover only the inner part of the ear, sometimes spread over the whole ear, and in a few specimens of nearly every variety continue up over the normally smooth areas between the ears and the first rib on the main part of the valve; byssal notch fairly sharp and deep; the whole surface including the ears, but especially the spaces between the ribs, covered with fine concentric lines of growth.

Dall says, in speaking of the group as a whole (p. 748), "The variations in the fossils parallel those of the living forms; the concentric sculpture may be weaker or stronger, may be visible on the backs of the ribs or only in the interspaces. The ribs may be more or less emphatic, rounded or flat-topped with lateral angles. In the latter case the concentric sculpture sometimes stops short at the angle, leaving the unworn back of the rib smooth, as if the concentric lamellæ had been worn off. In this case, which is the most conspicuous of the various mutations, the ribs appear laterally fringed. All the species of this group, recent or fossil, show this mutation occasionally, though it is rarer among the recent shells than among the fossils."

There is great hesitancy on the part of conchologists and even of paleontologists to recognize the specific identity of related forms which are found on the two sides of the continent, even though the morphologic characters of these forms fall within the limits of specific variation. This feeling has really had a detrimental effect on the science, for it has obscured the true relations of the forms and spread the conception that the California province is entirely separate and impossible to correlate with other regions. There are a number of species on the Atlantic coast which are so close to our Pacific coast forms that if the two occurred together it would be impossible to distinguish them. If, in addition, it can be shown that the two forms belong to a common stock that has migrated from one coast to the other during the middle or late Tertiary or the Quaternary, the two should be classed under the same name. In such a case it is of considerable value to know that the two are the same, in addition to eliminating a superfluous name and diagnosis from the mass of material that each paleontologist must learn; and there is nothing at all to be gained by separating forms that it is reasonably certain are identical. The argument that the purely geographic separation of species enables a worker to tell from the name what region a specimen came from is absurd, for it is much easier and more likely to be intelligible to everyone to say such and such a species from such and such a locality than it is to give each geographic race a separate name when there are no distinguishing characters. An example of such a case is given by Davenport (*loc. cit.*, 1903), in his tabulation and analysis of the characters of a very large series of the living varieties of *Pecten gibbus* from Tampa, Florida, and from San Diego, California.

Davenport collected and measured considerably over five hundred specimens from each locality (having already studied several other large series of more northern varieties of the same species from the Atlantic). He examined the number of ribs and concluded that Tampa specimens average about one rib more per shell, but noted that the Tampa average is higher than that from any other locality which he had studied on the Atlantic coast, and that the San Diego average occupies an intermediate position. He found the convexity of the two lots not noticeably different, though the San Diego specimens are more variable. He measured the ratio between the dorsal half-length and the ventral half-length of the shells (i. e., the length of the shell behind a diameter drawn perpendicular to the hinge line at the beak and the length of the shell in front of that line, or in other words the obliquity of the valve) and found that as in most Pectens the dorsal half-length exceeds the ventral in both lots. The excess is 15% in the San Diego set and only 6% in the Tampa set. Davenport notes that the obliquity is not so great in the Pacific coast variety as in other Pacific coast living species (such as *Pecten latiauratus* Conrad); and implies therefore that the greater obliquity is attributable to the influence of local environment; but it is largely on account of this difference that the San Diego form is here accorded varietal distinction. Davenport discusses also the similarity in color markings, noting the positions of the characteristic light-colored ribs that are found in many specimens of both series, and showing that the correspondence of position is more than coincidental. Having demonstrated by means of the details of color markings, as well as by the similarity of general proportions, the close relationship of the two forms, he goes on to inquire into their ancestry, pointing out that Dall has recorded in the Miocene forms indistinguishable from the typical variety, and recalling the connection which is known to have existed between the two oceans at that time. Thus we have the explanation of the common form in the ancestry. Neither branch of the original race has changed sufficiently since the separation to become a distinct species. As Davenport has already observed, it is sometimes easier to tell the specimens from different localities along the Atlantic coast than it is to tell the Atlantic coast forms from the Pacific coast. Of the various varieties of *Pecten gibbus* the Pacific coast variety *circularis* is the closest to the typical form.

The species is recorded then in its typical form from the Miocene of Virginia (Dall), from the Pliocene of Florida (Dall) and of Trinidad (Maury), from the Pleistocene of the Carolinas, Florida, and the Antilles (Dall). The variety *demiurgus* Dall is recorded from the Miocene of Trinidad; and two other varieties, *venezuelanus* and *cornellanus*, both of F. and H. Hodson (Bulls. Amer. Paleo. No. 49, pp. 25 and 26, with plates, 1927), are recorded from the Miocene of Venezuela and the Canal Zone. The last two authors describe still another variety from the Pliocene of the Canal Zone (*caucanus*, p. 27, pl. 15, figs. 1, 8); and Dall describes variety *amplicostatus* from the Pliocene of Florida and lists variety *borealis* Say from the Pleistocene of Florida. The records of *P. mendenhalli*, *P. circularis*, and *P. abictis* made by Hertlein and by Jordan and Hertlein from the Pliocene of Lower California should probably be referred to variety *demiurgus* Dall; and the records of *P. calli* by the same authors from the Pliocene of Lower California and of *P. circularis* var. *æquisulcatus* by various authors from the Pleistocene of California should be referred to the variety *circularis*. The species is living today from New England to Brazil and from southern California to Peru, and is also reported from the west coast of Africa. The New England variety is classified by Dall as var. *borealis* Say, that from the middle Atlantic states as var. *irradians* Lamarck, that from Cape Hatteras to Brazil and west Africa as typical *gibbus*, the variety inhabiting fuci as var. *nucleus* Bonn, another supposedly ecologic form as var. *amplicostatus* from Texas to Cartagena, the form ranging from California to Peru as *P. circularis*, and the larger, less convex form from California and Lower California as var. *æquisulcatus* of *circularis*.

Thus it is seen that the species has, and has had in the past, a very wide distribution. The metropolis of the species appears to have been in the Caribbean, from which it has radiated out in all directions. In various articles Davenport has pointed out that even between the extreme northern varieties, *irradians* and *borealis*, which would otherwise be specifically separated from *gibbus*, there is a very complete and gradual intergradation. In adapting themselves to colder climates the individuals of the species tend to become less convex, with the ribs rounder and more widely spaced. The same tendency is shown much less strongly by *æquisulcatus*, the northern form from the Pacific coast.

It is possible that *Pecten eboreus* Conrad and its varieties, including perhaps the forms here described as varieties of *P. deserti*, may be the ancestors of *Pecten gibbus*. They appear to have radiated from the common center so as to arrive in most regions just ahead of the varieties of *gibbus*, though some of them managed to live on for some time after the arrival of the latter species. In some cases it is difficult to distinguish the two.

The typical variety of *Pecten gibbus* is characterized by moderate size; strong convexity of the valves, the right valve more convex; 17 to 23 ribs, averaging 20 with a tendency toward a slight reduction in number in the fossils, ribs fairly high and flat-topped; obliquity averaging 6%; and a wide range of coloration, usually of bright colors. Variety *amplicostatus* Dall has but 15 or 16 ribs, which are broader and more solid; and it is usually white on the right valve and mottled gray on the left. Variety *nucleus* Born has 21-23 ribs, is smaller, thinner, and polished, variegated with gray, white, and dark brown. Variety *irradians* Lamarck has from 17 to 22 ribs, averaging 19, the ribs varying from angulated to rounded, sometimes showing striæ as in *P. opercularis* Lamarck, the type of the subgenus *Aequipecten*. It is less convex than typical *gibbus*, has a somewhat thinner shell and more sombre coloration, preferring deeper water. Variety *borealis* Say is like *irradians*, being but a more extreme variation in the same direction, with rounded, fewer, more distant ribs, and lower convexity, the two valves becoming almost equally convex. Variety *venezuelanus* F. and H. Hodson has about 19 fairly broad, flat-topped ribs, strong convexity, the right valve being the more convex, and has an estimated obliquity of about 11%. Variety *cornellanus* F. and H. Hodson recalls the description of *amplicostatus*, with 17 or 18 fairly broad, square-sided, flat-topped ribs, and (according to Hodson's figures) a low obliquity as in *gibbus*, *s. s.* Variety *caucanus* F. and H. Hodson is like variety *venezuelanus* but with more prominent striations on the ribs. The other varieties will be more fully described below.

Pecten (**Aequipecten**) **gibbus** (Linnæus) variety **circularis** Sowerby

Plate 5, Figures 7*a*, 7*b*, 7*c*

Pecten tumidus Sowerby, Proc. Zool. Soc. London, p. 109, 1835, not *Pecten tumidus* Turton, 1822, nor Zeiten, 1830.

Pecten circularis Sowerby, Proc. Zool. Soc. London, p. 110, 1835; Thes. Conch., Vol. 1, p. 51, pl. 12, fig. 23, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 31, species 137, 1852; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 24, pl. 1, figs. 1, 2, 1920.

Not *Pecten circularis* Goldfuss, Petrifacta Germaniæ, Vol. 2 (pt. 5), p. 76, pl. 99, figs. 10*a*, 10*b*, 1836, Ed. 2, p. 72, pl. 99, figs. 10*a*, 10*b*, 1862.

Pecten ventricosus Sowerby, Thes. Conch., Vol. 1, p. 51, pl. 12, figs. 18, 19, 26, 1842, new name for *P. tumidus;* Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 7, species 31, figs. *a*, *b*, 1852; Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 104, 1868-9; Küster and Kobelt, Martini-Chemnitz Syst. Conch. Cab., Ser. 2, Vol. 17, Pt. 2, p. 100, pl. 28, figs. 1-3, 1888; Cooper, 7th Annual Report, Calif. St. Mineralogist, p. 258, 1888; Davenport, Mark Anniversary Volume, pp. 123-136, pl. 9, 1903; Keep, West American Shells, p. 41, 1904; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 256, 1909; Peile in Bosworth, Geol. and Paleo. of N. W. Peru, p. 178, pl. 25, fig. 10, 1922 (MacMillan & Co., London).

Pecten [*ventricosus* var. ?] *æquisulcatus* Carpenter, Brit. Assn. Adv. Sci. Rept. for 1863, p. 645, 1864; Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 179, 1865; Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 711, 1898.

Pecten (*Dentipecten*) *circularis* Sowerby, Küster and Kobelt, Martini-Chemnitz Syst. Conch. Cab., Ser. 2, Vol. 17, p. 188, pl. 51, figs. 5-8, 1888.

Pecten æquisulcatus Carpenter, Küster and Kobelt, Martini-Chemnitz Syst. Conch. Cab., Ser. 2, Vol. 17, p. 269, pl. 71, figs. 1, 2, 1888; Keep, West Coast Shells, p. 166, fig. 139, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 193, (1892) 1893; Orcutt, West American Scientist, Vol. 12, p. 11, 1901; Williamson, Bull. So. Calif. Acad. Sci., Vol. 1, no. 5, pp. 51-64, pls. 4-6, 1902; Keep, West American Shells, p. 39, fig. 18, 1904.

Pecten (*Pecten*) *compactus* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 707, pl. 34, fig. 5, 1898; figure reproduced by Arnold, Prof. Paper 47 U. S. Geol. Survey, pl. 44, fig. 7, 1906.

Pecten (*Plagioctenium*) *subventricosus* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 707, pl. 29, fig. 8, 1898; figure reproduced by Arnold, Prof. Paper 47 U. S. Geol. Survey, pl. 44, fig. 5, 1906.

Pecten (*Plagioctenium*) *ventricosus* Sowerby, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 710, 1898 (+ *P. inca* d'Orbigny 1847, = ? *P. pomata* Valenciennes, Voy. Venus, pl. 19, fig. 3, 1835, *fide* Dall); Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 114, pl. 11, figs. 3, 3*a*, 6, 6*a*, 1903.

Pecten (*Plagioctenium*) *newsomi* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 113, pl. 11, figs. 1, 1*a*, 1903.

Pecten (*Plagioctenium*) *circularis* Sowerby, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 125, pl. 42, figs. 3, 4, 5, 6, pl. 44, figs. 6, 6*a*, 6*b*, 7, 1906; Eldridge and Arnold, Bull. 307, U. S. Geol. Survey, p. 242, pl. 35, fig. 4, 1907; Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 58, 1924; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 214, pl. 23, fig. 9, 1926; also p. 438, in part, 1926.

Pecten (*Plagioctenium*) *circularis* var. *æquisulcatus* Carpenter, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 132, pl. 50, figs. 1, 1*a*, 1*b*, also text figure 1 on p. 45 and 2 on p. 46, 1906; Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 58, pl. 42, figs. 1, 2, 1924.

Pecten (*Plagioctenium*) *calli* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 16, pl. 4, fig. 6, not figs. 5 and 7, (fig. 6 is of the type), 1925; Jordan and Hertlein, Vol. 15, p. 436, pl. 27, fig. 5, 1926.

Pecten (*Chlamys*) *circularis æquisulcatus* Carpenter, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

? *Pecten* (*Plagioctenium*) *ericellus* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 18, p. 215, pl. 24, figs. 10, 11, 1929.

Like the typical variety in all respects except that the obliquity (as explained above) averages 15% instead of 6%, that is, more specimens are drawn out obliquely than is the case with the typical variety.

Dimensions: Altitude, 44 mm.; length, 46 mm.; length of hinge, 33 mm.; convexity of right valve, 15 mm., of left valve, 12 mm.

Type specimens: Of *circularis*, *ventricosus*, and *æquisulcatus*, British Museum (?); of *compactus* and *subventricosus*, both No. 61,246, and of *newsomi*, No. 162,524, in the U. S. National Museum; of *calli*, No. 68 in the collection at Stanford University; of *ericellus*, No. 2,998 at the California Academy of Sciences.

Type localities: Of *circularis*, living, Gulf of California; of *ventricosus*, living, west Colombia; of *æquisulcatus*, living, Santa Barbara, Calif.; of *compactus* and *subventricosus*, Pleistocene of Ventura Co.; of *newsomi*, Pleistocene of Signal Hill (Los Cerritos), Los Angeles Co.; of *calli*, east of Santiago, Lower California, probably Pliocene; of *ericellus*, Pliocene of Pacific Beach, San Diego.

Pliocene: Lower California (Jordan and Hertlein as *circularis* and as *calli*, though part of the occurrences listed as *circularis* may be closer to variety *demiurgus* Dall—those with the "rounded ribs"); (Pliocene ?) Cholas Valley, near San Diego (Stearns in Arnold 1906); ? Pliocene of Pacific Beach, San Diego (Hertlein as *ericellus*).

Pleistocene: Ventura, San Pedro, San Diego (Arnold, etc., also as var. *æquisulcatus*); "Saugus" of Ventura County (Waterfall); Lower California (Jordan and Hertlein); Borego Springs, Colorado Desert (Orcutt).

Living: Monterey, Calif., to Payta, Peru (Dall, 1921); as *æquisulcatus*, Santa Barbara, Calif., to Cape San Lucas, Lower Calif. (Dall, 1921).

The long list of synonyms bears witness to the great variability of this variety. Conchologists have long tried to keep *ventricosus* separate from *circularis*, but now it is generally acceded that the two are nearly identical. Some conchologists still try to keep variety *æquisulcatus* separate on the grounds that it is a larger and less convex form. Arnold gives for its dimensions: Alt., 72 mm.; long., 83 mm.; hinge line, 51 mm.; diameter, 36 mm.; umbonal angle 100°. It is also said to have a thinner shell, narrower ribs, and more subdued coloration, which recalls the analogous variety *irradians* of the Atlantic coast, though the modification has not gone so far with *æquisulcatus*. The range also appears to have a significance, for this variety is said not to occur outside of California and the west coast of Lower California. Hence it may be found desirable to attempt the separation of *Pecten gibbus* var. *æquisulcatus*, though it would be just as easy, when the forms are so much alike, to remember it as the northern modification of variety *circularis*. W. C. Mansfield of the U. S. National Museum very kindly informed the writers after examining the types of *compactus* and *subventricosus* that he believed them to be the right and left valve of *P. circularis* respectively. Arnold himself listed *newsomi* as the young of *æquisulcatus*. Hertlein accedes that *calli* is but the young or a stunted localized form of *circularis*. The form *ericellus* is an individual variant in the evolutionary series between *P. purpuratus* and *P. gibbus* variety *circularis;* but it has already advanced far enough so that it can be matched in all its characters, ventricosity, number and character of ribs, and secondary ribs, by young living specimens of the form *æquisulcatus*, and hence should be assigned here. In some respects it resembles the varieties of *P. deserti* from the middle Pliocene of the Ventura basin, but it has too many ribs.

Pecten (**Aequipecten**) **gibbus** (Linnæus) variety **demiurgus** Dall (?)

"*Pecten comparilis* Tuomey and Holmes," Guppy, Geol. Mag., Decade 2, Vol. 1, 1874.

Pecten (*Plagioctenium*) *demiurgus* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 718, pl. 26, fig. 3, 1898; Maury, Bulls. Amer. Paleo., No. 42, p. 85, or Vol. 10, p. 237, pl. 14, fig. 5, pl. 16, fig. 6, 1925.

"*Pecten* (*Plagioctenium*) *cerrosensis mendenhalli* Arnold," Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 16, pl. 1, fig. 5, 1925.

Pecten (*Plagioctenium*) *abietis* Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 214, pl. 23, figs. 1, 3, 7, 1926.

"*Pecten* (*Plagioctenium*) *circularis* Sowerby" Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 438, 1926.

"*Pecten* (*Plagioctenium*) *mendenhalli* Arnold" Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 442, 1926.

Type specimens: Of *demiurgus*, No. 115,527 in the U. S. National Museum; of *abietis*, No. 2,079 at the California Academy of Sciences.

Type localities: Of *demiurgus*, Miocene of Trinidad; of *abietis*, Pliocene of Maria Madre Island off the southwest coast of Mexico.

Miocene: Trinidad (Guppy; Dall; Maury).
Pliocene: Lower California (Jordan and Hertlein).

This variety is distinguished by its large size, twenty strong, broadly rounded ribs with very narrow interspaces, its moderate convexity, with the right valve usually a little more convex, and obliquity like that of the variety *circularis.*

The original description stresses the high, narrow umbones and inset ventral ears, and one of the specimens in the Stanford collection from Lower California agrees in these respects with the type description and figure; but other specimens from the same locality which are almost surely the same are of a more normal shape, and Miss Maury's figure of a specimen from the type locality in Trinidad does not show the shape of the type; indeed, Miss Maury's figure bears in some respects a closer resemblance to the variety *æquisulcatus* than it does to *demiurgus.* At all events, it seems to be the shape of ribs and the narrow interspaces, with the size and moderate convexity, that characterize this variety, and the narrow umbones are not essential.

Hertlein no longer holds that the forms from Lower California ascribed by him to *mendenhalli* are the true *mendenhalli* of Arnold. Indeed, it seems probable that the rounded ribs of the form described by Hertlein as well as the triangular ribs described by Jordan and Hertlein as the characteristic of *abietis* are a peculiar result of weathering, for one specimen shows patches of rounded ribs and of triangular ribs on the same valve. Some of the specimens of "*P. circularis*" with the "rounded ribs" reported by Jordan and Hertlein from Lower California probably also belong here. This variety appears to have migrated from the Atlantic to the Pacific along with the typical variety.

Pecten (Aequipecten) hallæ Dall

Pecten (Plagioctenium) hallæ Dall, Nautilus, Vol. 34, p. 76, 1921.

Type specimen: No. 33,042 in the U. S. National Museum.

Pliocene ?: Nome, Alaska.

This species has not been figured, and the description alone is not sufficient to show its relationships. Apparently it has a right valve like that of *P. gibbus* var. *circularis* (or *æquisulcatus*), but it is much larger (altitude 120 mm. or more).

Subgenus **JANIRA** Schumacher, 1817

Vola Klein, 1753, pre-Linnæan.

Pecten Müller, 1776, in part only (see reference under *Pecten, s. s.*); Bolten, Mus. Boltenianum, p. 165, 1798; Lamarck, Prodr., Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 88, 1799; Children, Quart. Journ. Sci., Lit., Arts,. Vol. 15, p. 40 (pl. 2, fig. 89), April, 1823, type designated, *Pecten maximus* = *Ostrea maxima* Linnæus; Gray, Proc. Zool. Soc. London, p. 200, 1847, type cited, *Ostrea maxima* Linnæus; Dall; Arnold; Woodring; etc.

Pandora Megerle von Mühlfeld, 1811, not of Bruguière, 1792, nor of Hwass in Chemnitz, 1895, nor of Lamarck, 1799.

Janira Schumacher, Ess. Nouv. Syst. Hab. Vers. Test., pp. 40, 117, 1817.

Type (by original designation), *Janira intermedia* Schumacher, p. 118, pl. 3, fig. 4, probably the same as or a variety of *Pecten maximus,* though the grooves and ridges diverging from the resilial pit are shown to curve out farther; Recent, Norway to the Mediterranean.

Shell with the right valve convex and the left nearly flat, sometimes concave, sculptured with a moderate number of ribs, which are sometimes radially striate; ears nearly equal, usually squarely terminated, the byssal notch almost obsolete.

Geologic range: Eocene to Recent, possibly older.

Distribution: Warm and temperate waters of all oceans.

The Mesozoic subgenus *Neithea* Drouet has the same general form as *Janira*, but it is quite likely that it was derived from *Chlamys* independently, and the writers are for the present inclined to think that *Janira* comprises a group of species of not very great antiquity, not any more distinct from *Chlamys* than the other subgenera.

Section JANIRA, s. s.

Ribs strong and radially striate.

Section NOTOVOLA Finlay, 1926

Notovola Finlay, Trans. New Zealand Institute, Vol. 57, p. 451, 1926; Marwick, Vol. 58, p. 448, 1927.

Type (by original designation), *P. novæzelandiæ* Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 8, species 36, 1852, living, New Zealand.

Ribs not radially striate.

Marwick mentions that *P. laqueatus* and *P. bellus* should be referred to this section. The writers believe that this section is of practically no significance and that it may do more harm than good to separate it from the typical, perhaps dividing related species.

The Pliocene Janiras may be thought of as a series varying from the flat forms like *P. bellus* and *stearnsii* to the very convex *vogdesi*. There are six species. The first is rather distinct from the others, being most closely related to *P. bellus*. It is represented by the form *aletes* Hertlein, which is probably only a variety of *P. humphreysii* Conrad from the Miocene of Maryland and of *P. laqueatus* Sowerby now living in Japan. This form is characterized by its few, broad, flat-topped ribs. It may have been derived from *P. vanvlecki* Arnold,[1] a lower Miocene species. The other species are all more or less intergrading. *P. stearnsii* and its varieties have a depressed form and numerous ribs, which often have a tendency to be grooved. *P. bellus* has a moderate number of ribs, and typically is depressed; but in the varieties *hemphilli* and *coalingaënsis* the right valve becomes more convex, and these forms eventually grade over into *P. vogdesi*. *P. vogdesi* has a very convex right valve, with rounded ribs, and on the left valve strong intercalaries. *P. hartmanni* Hertlein has also a very convex right valve, but it has a narrow shell and few ribs. *P. keepi* is a *P. vogdesi* on which the ribs have become nearly obsolete.

Pecten (Janira) humphreysii Conrad

Pecten humphreysii Conrad, Bull. of the Proc. of the National Institute for the Promotion of Science, Washington, D. C., No. 2, p. 194, pl. 2, fig. 2, 1842, published before the American Journal of Science, Vol. 43, Pt. 1, p. 216, April to June, 1842.

Pecten laqueatus Sowerby, Thes. Conch., Vol. 1, pt. 2, p. 46, pl. 15, fig. 101, 1842, published between August 1 and November 2, 1842.

Vola humphreysii Conrad, Whitfield, Monograph 24 U. S. Geol. Survey, p. 32, pl. 4, figs. 6, 7, 8, 9, 1894.

Pecten (Pecten) humphreysii Conrad, Glen, Maryland Geol. Survey, Miocene Volume, p. 372, pl. 98, figs. 10, 11, 12, 1904.

Shell of moderate size, right valve of moderate convexity, sculptured with seven or eight large, broad, flat-topped ribs and one or two minor ribs at each side; left valve nearly flat, with a similar number of low, squarish, narrow ribs; ears nearly smooth or finely, radially striate.

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[1] *Pecten (Pecten) vanvlecki* Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 10, (separate pagination), pl. 53, figs. 1, 2, 1907, figures reprinted in Bull. 322 U. S. Geol. Survey, pl. 17, figs. 1, 2, 1907.

Miocene: Maryland, New Jersey, etc. (Conrad; Whitfield; Glenn).

Miocene-Pliocene: Lower California (see the variety *aletes*).

Living: Japan.

The two well-known forms, *humphreysii* and *laqueatus*, are so very much alike that they probably cannot be distinguished and are here tentatively considered synonymous in spite of their very distant occurrences. The variety *aletes* explains and unites these two widely separated occurrences, for it is a form probably not more than varietally distinct, being apparently a local off-shoot that separated from the main stock as it migrated from Maryland to Japan. Whether the synonymy as given above be accepted or not, the fact of primary importance cannot be doubted that this species or group of forms migrated, probably during the Miocene, between Maryland and Japan through California. A single instance of this sort is sufficient to prove that the provincialism of the California faunas is entirely mythological and to show that migration has occurred between this region and others, that some species must have come here from the other regions, and that therefore the faunas of the other regions must be taken account of and some of the specific names applied to California forms. Furthermore, this instance does not occur alone but is accompanied by many others. The Pectens supply the cases best known to the present writers, who have studied them more with this idea in mind, but similar cases have been noticed in other genera such as *Corbula*, *Psephœa*, *Nucula*, *Pitar* (*Amiantis*), *Mactra*, etc. Provincialism has deprived California paleontologists of one of the most helpful aids in making correlations and has kept in the dark some of the most interesting chapters of this part of natural history.

Pecten (Janira) humphreysii Conrad variety **aletes** Hertlein

Pecten (*Pecten*) *aletes* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 8, pl. 2, figs. 1, 4, 1925.

Shell like that of the typical variety, but with higher, more T-shaped ribs on the right valve, these ribs more strongly overhanging the interspaces, which on the right valve are consequently wider and allow the ribs of the left valve to be wider also; a few indistinct longitudinal grooves present on the tops of the ribs of the right valve.

Dimensions: Altitude, 62 mm.; length, 65 mm.; length of hinge, about 32 mm.; diameter of right valve (possibly somewhat crushed), 13 mm.

Type specimen: No. 44 in the type collection at Stanford University.

Type locality: North of San Jose del Cabo, Lower California.

Upper Miocene or *lower Pliocene:* Type locality.

The main stock of this species is so variable that it is not certain whether the characters separating this variety are significant or not.

Pecten (Janira) stearnsii Dall

"*Janira dentata* Sowerby" Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 104, 1868-9, in part *fide* Arnold; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 244, 1888, in part *fide* Arnold.

Pecten stearnsii Dall, Proc. U. S. Nat. Mus., Vol. 1, p. 14, 1879.

Pecten (*Pecten*) *stearnsii* Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 706, pl. 26, fig. 5, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 106, pl. 12, fig. 3, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 100, pl. 32, figs. 1, 1*a*, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pp. 152, 153, pl. 35, fig. 2, pl. 36, fig. 4, 1907; Arnold and Anderson, Bull. 322, p. 59, pl. 25, figs. 1*a*, 1*b*, 1907; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 417, 1926.

Pecten (*Pecten*) *beali* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 10, pl. 2, fig. 3, pl. 5, fig. 8, 1925.

Shell about 70 mm. in diameter, subcircular, plano or concavo-convex, fairly thin; right valve of low convexity, with 18 to 24 regular, even, squarish ribs, separated by interspaces somewhat narrower than the ribs, the top surface of each rib flattened and often grooved or sulcated; ears nearly equal, arched, covered with crowded, elevated lamellæ and sometimes indistinct radiating ridges, byssal notch very small; left valve flattened or concave, with regularly rounded, even ribs, separated by slightly wider interspaces, which sometimes have an inconspicuous mid-rib, the whole surface covered with fine, sharp, concentric, regular lamellæ; ears of this valve concave, with indistinct radiating ridges and fine concentric lamellæ.

Dimensions: Altitude, 62 mm.; longitude, 71 mm.; diameter, 14 mm.; length of hinge, 25 mm.

This species is represented by a somewhat limited series of variations which are probably closely related genetically with *Pecten bellus* and its varieties.

Variety **stearnsii**, s. s.

Plate 3, Figures 2*a*, 2*b*

Type specimens: Of *stearnsii*, No. 7,942 in the U. S. National Museum; of *beali*, No. 55 in the type collection at Stanford University.

Type localities: Of *stearnsii*, Pliocene of San Diego; of *beali*, from arroyo near La Palma, Lower California, Salada contact, Pliocene.

Pliocene: Pacific Beach, San Diego (Dall; Arnold); Santa Maria district (Arnold, 1907); Temescal Canyon, Santa Monica Mts., Los Angeles Co. (Watts; Rivers in Arnold); Lower California (Hertlein; Jordan and Hertlein; partly as *beali*); loc. 217*a* S. D. S. N. H., middle Pliocene of Holser Canyon, Los Angeles Co., three specimens, one of which has no sulcations on the ribs (H. R. G.); loc. 228, middle Pliocene southeast of Pico Canyon, Los Angeles Co., three large specimens none of which have sulcations on the ribs (H. R. G.); Third Street tunnel, Los Angeles (Arnold).

Pleistocene: "Pliocene" of San Pedro (Arnold 1903).

? Living: Some living specimens look as much like this variety as they do like *diegensis*.

This typical variety is distinguished by its numerous ribs (23-24, possibly even 26), the ribs when characteristic being high and comparatively narrow, and on the right valve more or less deeply grooved, the hinge line very short, less than half the length of the shell. The distinction is drawn more according to the number of the ribs and the length of the hinge line than according to the sulcations on the ribs, for many living specimens have grooved ribs and many fossils have entire ribs. The distinction is of doubtful value. The form *beali* is too close to separate, though the type specimen is interesting, as it shows a tendency for the two parts of the sulcated ribs to split again like the ribs of *Arca trilineata*.

Pecten (Janira) stearnsii Dall variety **diegensis** Dall

Plate 3, Figure 4

"*Pecten floridus* Gmelin," Hinds, Zool. Voy. Sulph., p. 60, pl. 17, fig. 6, 1844; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 8, fig. 34, 1852.

"*Pecten* (*Vola*) *floridus* Gmelin," Küster and Kobelt, Syst. Conch. Cab., Vol. 17, pl. 57, fig. 2, 1888.

"*Janira florida* Gmelin," Cooper, 7th. Ann. Rept. Calif. St. Mineralogist, p. 244, 1888.

Pecten (*Pecten*) *diegensis* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 710, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 106, pl. 12, fig. 5, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 127, pl. 51, figs. 1, 1*a*, 1*b*, 1906; Dall, Bull. 112 U. S. Nat. Mus., p. 18, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 51, pl. 29, fig. 5, pl. 41, fig. 3, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pecten diegoensis Dall, Keep, West. Amer. Shells, p. 39, 1904.

Type specimen: No. 150,980 in the U. S. National Museum.

Type locality: Living, San Pedro, Los Angeles Co.

Pliocene: Middle Pico of locality 226, Ventura County, one specimen (H. R. G.); uppermost Pliocene of Ventura Co. (Waterfall).
Pleistocene: San Diego (Hemphill in Arnold).
Living: Monterey Bay to San Diego and the Cortez Bank (Dall); in all cases dredged (Arnold).

This variety is distinguished from the typical form by its fewer ribs (18 to 21), with wider interspaces, and by its generally longer hinge line. The ribs are usually lower and are less often sulcate. The right valve may be flatter than that of the typical variety, in which case the left valve becomes somewhat convex.

This variety is distinguishable from the typical variety of *Pecten bellus* by its longer hinge line and larger number of ribs.

The single specimen collected from locality 226 is much like the living specimens, having low convexity, 18 medium high, squarish, non-sulcated ribs, and a hinge line about half as long as the shell. If the characters of the variety *diegensis* are to be depended upon at all, this specimen must be included, even though it comes from a horizon thought to be of middle Pico age. The ribs are a little wider than on living *diegensis*, this form being apparently a connecting link with *bellus*. Locality 226 is near the mouth of Smith Canyon, the first canyon east of Torrey Canyon, south of the town of Piru, Ventura County, directly overlying hard calcareous Modelo sandstones, and described by Kew (1924) as basal Pico. It is thought by the writers, however, to be of middle Pico age, the basal Pico not being represented in that particular locality.

Among the living and fossil specimens, there are some which have the number of ribs typical of *stearnsii*, *s. s.*, but have the shape of ribs characteristic of *diegensis*. There are others with longer ears. The ultimate distinction is made on the basis of the number of ribs, and not upon the shape.

Pecten (Janira) stearnsii Dall variety **carrizoensis** Arnold

Pecten sp. indet., Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 706, line 13, 1898, *fide* Arnold.
Pecten (*Pecten*) *carrizoensis* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 59, pl. 4, figs. 1, 1*a*, 1*b*, 2, 3, 3*a*, 1906; Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 2, 1925; Hanna and Hertlein, Vol. 16, p. 141, 1927.
Pecten carrizoensis Arnold, Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 470, 1926.

Type specimen: No. 11 in the type collection at Stanford University.

Type locality: Head of Garnet Canyon, about 12 miles north of the Mexican boundary in the Carrizo Creek district.

Pliocene: Carrizo Creek district (Arnold; Hertlein; Hanna); Santa Rosalia, Lower California (Arnold); Santa Antonita Point, Lower California (Hanna and Hertlein); "Miocene" of San Diego (Dall).

This variety is a smaller stunted form with fewer ribs (18), otherwise indistinguishable from the variety *diegensis* and the typical *stearnsii*.

Pecten (Janira) stearnsii Dall variety **bakeri** Hanna and Hertlein

Plate 4, Figures 1*a*, 1*b*

Pecten (*Patinopecten*) *bakeri* Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 153, pl. 5, fig. 1, 1927.
Pecten (*Pecten*) *bösei* Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 154, pl. 5, figs. 2, 3, 1927.

Shell like that of the typical variety but with low, smooth, slightly flat-topped ribs, the intercalary between the ribs well developed on the left valve, and on large specimens faintly showing on the right also.

Dimensions: Altitude, 113 mm., length, about 122 mm.; length of hinge, about 55 mm.; convexity of right valve, 15 mm., of left valve, 4 mm.

Type specimens: Of *bakeri*, No. 1,865, of *bösei*, Nos. 2,215 and 2,216 (cotypes), at the California Academy of Sciences.

Type localities: Of *bakeri*, 15 miles north of Loreto, Lower California; of *bösei*, near Santa Antonita Point, Lower California.

Pliocene: Type localities, Lower California; loc. 32, S. D. S. N. H., Santa Rosalia, Lower California, one fine specimen (collected by Marcel Touwaide).

The two forms described by Hanna and Hertlein in the same paper and figured on the same plate do not look at all alike in the original illustration. Indeed, one was assigned to a different subgenus. Fortunately, however, the specimen herewith figured, which is much better than the type of *bakeri*, and has both valves well preserved, shows beyond a shadow of a doubt that *bakeri* is a *Janira* and that *bösei* is the young of it. The original illustration of *bakeri* is misleading, for it makes the ribs look very broad and shows the shallow sulcations in a peculiar manner. What appears to be a rib in the original illustration is really the entire area between a mid-rib and the far side of the first main rib to the right.

Pecten (Janira) bellus (Conrad)

Janira bella Conrad, Proc. Acad. Nat. Sci., Phila., for 1856, p. 312, 1857, reprinted by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 173, 1909; U. S. Pacific Railroad Survey, Reports, Vol. 6, p. 71, pl. 3, fig. 16, 1867, description reprinted by Dall, *op. cit.*, p. 178, 1909; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 244, 1888.

Pecten (Pecten) bellus Conrad, Dall, Trans. Wagner Free Inst. Sci., Phila., p. 704, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 103, pl. 21, figs. 1, 2, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 95, pl. 31, figs. 1, 1*a*, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 24, pl. 35, fig. 3, 1907; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 430, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 81, 82, 1929.

Pecten bellus Conrad, Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, p. 151, 1912; McLaughlin and Waring, Map Folio accompanying Bull. No. 69, Calif. St. Mining Bureau, pl. 1, fig. 46, 1914; Kew, Bull. 753 U. S. Geol. Survey, p. 88, 1924.

Shell moderately large, not very thick, varying in convexity from forms with a moderately arched right valve, which necessitates a distinct bulge in the left valve to provide the animal room to live, to forms with a strongly arched right valve and a slightly concave left, the umbones being in a few cases strongly arched and the later growth of the shell more expanded and flattened; ribs varying in number from about 12 to 18, either broad and square and not very high, or tending toward higher, narrower, or more rounded shapes, but in all cases rather widely spaced, enlarging noticeably toward the periphery, the whole surface of the shell ornamented with close, fine growth lines; hinge line short, only about half the length of the shell or slightly shorter, ears not long, but fairly deep, nearly equal, the right ventral somewhat arcuate but with hardly any byssal notch, marked with about four low, rounded, radiating riblets, the other ears almost squarely terminated, without the riblets, on some varieties the ears of the right valve noticeably convex or folded, those of the left smoothly concave.

This series of variations has been described as five distinct species, and all of the forms have not yet been named. Jordan and Hertlein have shown that two of the most distinct, *bellus* and *hemphilli*, intergrade perfectly in Lower California and are very difficult to distinguish there or even at San Diego. All of the other varieties are less distinctly characterized, probably representing nothing more than minor reactions to local conditions, and some of them it is hardly worth while to try to recognize.

Variety **bellus**, s. s.

Right (lower) valve only moderately convex, the point of greatest convexity being about one-third of the distance from the hinge to the posterior margin of the disk, the umbo curving sharply in some specimens and meeting the plane of the ears perpendicularly; ribs prominent, 12 to 15 in number, broad, flat-topped, with flat, steeply sloping sides, sometimes marked by one or two indistinct longitudinal grooves, growing broader, less elevated, and less sharply angled near the periphery;

hinge line short; left valve only slightly convex, outline smoothly curving or varied with a depressed area just under the beaks; ribs much as in the right valve, but narrower and higher, more distant, sometimes slightly grooved in the center.

Dimensions of a large specimen from the type locality: Altitude, 98 mm.; length, 105 mm.; length of hinge, 48 mm.; convexity of right valve, 25 mm., of left valve, 5 mm.

Type locality: Uppermost Pliocene near Santa Barbara.

Middle Pliocene: San Deigo and Lower California (Jordan and Hertlein).

Upper Pliocene: Santa Barbara (Conrad; Cooper; Gabb; Arnold); Dry Canyon, north branch of Tapo Canyon, Ventura County (Kew); east side of Piru Creek, Ventura County (Watts); locality 221, Cañada de Aliso, Ventura County, ten fragments (H. R. G.); ? Temescal Canyon north of Santa Monica, Los Angeles County (Rivers).

Typical *bellus* is distinguished from its varieties by the more moderate convexity of its right valve, by the usually somewhat convex left valve, and by its broader, squarer ribs. From typical *stearnsii* it is distinguished by the fewer, broader ribs on the right valve, and the less strongly laminated ribs on the left valve; from *stearnsii* variety *diegensis* it is also distinguished by its shorter hinge line. It approaches distantly the form of *Pecten humphreysii.*

Pecten (Janira) bellus (Conrad) variety **hemphilli** Dall

Plate 3, Figures 1*a*, 1*b*

Pecten hemphilli Dall, Proc. U. S. Nat. Mus., Vol. 1, p. 15, 1879; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 257, 1888; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, pp. 150, 151, 152, 1912; Kew, Bull. 753 U. S. Geol. Survey, pp. 78, 88, in part ?, 1924.

Pecten (*Pecten*) *hemphilli* Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 706, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 105, 1903; Prof. Paper 47 U. S. Geol. Survey, p. 97, pl. 33, figs. 3, 3*a*, 3*b*, 1906; Arnold and Anderson, Bull. 322 U. S. Geol. Survey, p. 59, pl. 25, fig. 5, 1907; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 45, 1916.

Pecten (*Pecten*) *auburyi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 94, pl. 33, figs. 2, 2*a*, pl. 34, figs. 2, 2*a*, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, p. 153, pl. 35, fig. 7, 1907.

Pecten (*Pecten*) *lecontei* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 98, pl. 33, figs. 4, 4*a*, 4*b*, 1906; Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 2, 1925.

Pecten (*Pecten*) *bellus* Conrad, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 430, in part, pl. 32, fig. 2, pl. 33, figs. 1, 2, pl. 34, figs. 2, 3, 4, 1926.

Shell like that of *bellus, s. s.,* and grading into the typical variety, but characterized by a greater number of ribs (14 to 18, — in *auburyi* "16 to 17," in *lecontei* "about 17"), the ribs of both valves being generally higher, narrower and rounder; right valve more strongly convex, left valve concave (or flat in forms close to *bellus, s. s.*); shell often smaller.

Dimensions: Altitude, 60 mm.; length, 66 mm.; length of hinge line, 29 mm.; convexity, 17 mm.

Type specimens: Of *hemphilli,* No. 7,943 in the U. S. National Museum; of *lecontei,* No. 4 in the type collection at Stanford University.

Type localities: Of *hemphilli,* Pliocene of San Diego; of *auburyi,* 1 mile east of the Chandler wells, Puente Hills, Los Angeles Co.; of *lecontei,* Pliocene of Cedros Island, Lower California.

Pliocene: Type localities; also Temescal Canyon north of Santa Monica (Rivers in Arnold); Santa Maria, Santa Barbara Co. (Arnold as *auburyi*); Turtle Bay, Lower California (Jordan and Hertlein); ? Santa Clara Valley, Ventura and Los Angeles counties (Kew, in part ?); Fourth and Broadway, Los Angeles (Moody).

The form *auburyi* is a little more extreme in its characters than is the type of *hemphilli,* but not significantly so, being a little more convex, which makes the apical angle look smaller; the form *lecontei* has slightly lower and rounder ribs. These forms differ from *hemphilli* less than *hemphilli* differs from *bellus,* and they appear to have no stratigraphic and only a local geographic significance. Jordan and Hertlein probably were right in not considering *bellus* and *hemphilli* distinct species, but it seems to be advisable to preserve the distinction between them as varieties. In Ventura County they appear to have a stratigraphic significance, *hemphilli* grading upwards into *bellus*.

The variety *hemphilli* is distinguished from the variety *coalingaënsis* by its fewer ribs and by the broader tops and steeper sides of the ribs. It is distinguished from *Pecten vogdesi* Arnold by its fewer, squarer, more distant ribs, by its shorter hinge line, and by the absence of the mid-rib which is often present on the left valve of *vogdesi*.

Pecten (Janira) bellus (Conrad) variety **coalingaënsis** Arnold in Anderson

Plate 2, Figure 2

Pecten coalingaënsis Arnold, F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 2, p. 197, pl. 18, figs. 94-98, 1905.
Pecten (Pecten) coalingaensis Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 97, pl. 4, figs. 4, 4*a*, 5, 1906.
Pecten coalingaensis Arnold, Bull. 396 U. S. Geol. Survey, pp. 31, 35, 39, 42, 44, pl. 26, figs. 1, 2, 1910; Arnold and R. Anderson, Bull. 398 U. S. Geol. Survey, pp. 101, 119, 129, 132, 136, 137, 138, pl. 48, same figures, 1910.
Pecten coalingensis Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 219, 1917.
? Pecten hemphilli Dall, Kew, Bull. 753 U. S. Geol. Survey, pp. 78, 88, in part ?, 1924.

Shell like that of the variety *hemphilli* but typically with more triangular ribs on the right valve, the ribs with narrow, somewhat rounded tops and sides sloping at an angle of about 45° to the narrow bottoms of the interspaces, ribs 17-20 in number.

Type specimen (the one figured by Arnold, 1906, which may or may not be the type, as Anderson's publication appeared first): No. 7 in the type collection at Stanford University.

Type locality: Etchegoin formation, near Coalinga, middle California.

M. Pliocene: Common but confined to the *Pecten coalingensis* zone of the Etchegoin (Nomland); ? Santa Clara Valley, Los Angeles Co. (Kew); ? loc. 228 S. D. S. N. H. southeast of Pico Canyon, Los Angeles Co., about ten left and ten right valves (H. R. G.); loc. 230, one, loc. 231, four (loc. 226, one ?), south side of the Santa Clara Valley (H. R. G.).

It is probable that this variety should not be separated from *hemphilli*, for even at the type locality there are specimens with broader topped ribs and nearly vertical sides as in variety *hemphilli*. The specimens from the S. D. S. N. H. localities are generally of smaller size, have a large number (17-20) of small, clearly defined, but lower, rounder, somewhat flat-topped ribs, with a very variable convexity and shape, and a tendency for the free margins of the shell to contract suddenly as if deformed. This form is as distinct from *coalingaënsis* as *lecontei* and *auburyi* are from *hemphilli*, but it seems hardly worthy of a name. It resembles *lecontei* in ribs, and *coalingaënsis* in shape, especially those specimens of *coalingaënsis* which do not have the characteristic sub-triangular ribs. Its significance as a relative of *coalingaënsis* is greater than is its significance as a distinct (or abnormal) form.

Pecten (Janira) bellus (Conrad) variety **slevini** Dall and Oehsner

Plate 2, Figure 3

? Pecten hemphilli Kew, Bull. 753 U. S. Geol. Survey, pp. 78, 88, 1924.
Pecten (Pecten) slevini Dall and Oehsner, Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 118, pl. 3, fig. 9, pl. 4, fig. 4, 1928.

Shell like that of varieties *hemphilli* and *coalingaënsis*, but relatively much longer and with a somewhat crushed appearance.

Dimensions: Altitude, 47 mm.; length, 63 mm.; length of hinge, 27 mm.; convexity of right valve, 15 mm.

Type specimen: No. 2,944 at the California Academy of Sciences.

Type locality: East shore of Indefatigable Island, Galapagos Group, probably Pliocene.

Pliocene: Type locality; middle Pliocene of loc. 231 S. D. S. N. H., northwest of Pico Canyon, Los Angeles Co., one specimen (H. R. G.); of loc. 263, between Pico Canyon and the Newhall tunnel, several specimens (H. R. G.), common in the same horizon north of the Santa Clara Valley, the top of the marine Pliocene (H. R. G.).

This variety is probably a distorted form caused by the increasing brackishness of the water at the top of the marine sequence in the California locality. Like *coalingaënsis,* this variety should probably be reunited to *hemphilli.* It is a variation in the opposite direction from *auburyi,* which has a narrow, deep shell.

Pecten (Janira) vogdesi Arnold

Plate 3, Figures 3*a*, 3*b*

Pecten dentatus G. B. Sowerby, Proc. Zool. Soc. London, p. 109, 1835; Thes. Conch., Vol. 1, p. 49, pl. 15, figs. 105-6, 1842, not *Pecten dentatus* J. Sowerby, Min. Conch. Gt. Brit., Vol. 6, p. 143, pl. 574, fig. 1, 1829; Verrill, Trans. Conn. Acad. Sci., Vol. 10, p. 57, 1897.

Not *Pecten excavatus* Anton, Verzeichniss der Conchylien, p. 19, No. 710, 1839, *correctly* reported from China. *Pecten sinensis* Sowerby is a synonym of *excavatus* Anton.

"*Pecten excavatus* Anton," Valenciennes, Voy. Venus, pl. 19, fig. 1, 1846.

Vola dentata Sowerby, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 554, 1853.

Janira dentata Sowerby, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 645, 1864; Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 104, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 244, 1888.

Pecten (*Vola*) *dentatus* Sowerby, Küster and Kobelt, Martini-Chemnitz Syst. Conch. Cab., Ser. 2, Vol. 17, Pt. 2, p. 155, pl. 44, figs. 1, 2, 1888.

Pecten (*Pecten*) *dentatus* Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 104, 1903.

Pecten (*Pecten*) *vogdesi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 100, pl. 33, figs. 1, 1*a*, pl. 34, fig. 1, 1906 Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pl. 35, fig. 5, 1907.

Pecten (*Pecten*) *excavatus* Anton, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 134, pl. 46, figs. 1, 1*a*, 1*b*, 1906.

Pecten (*Euvola*) *cataractes* Dall, Nautilus, Vol. 27, p. 121, 1914, new name for *dentatus* G. B. Sowerby.

Pecten (*Pecten*) *heimi* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 9, pl. 1, fig. 3, pl. 3, fig. 3, 1925.

Shell averaging about 90 mm. in altitude, about as long as high, plano-convex or slightly concavo-convex, equilateral, with more or less coarsely serrate margins, sides concave above; right valve very convex, the umbo projecting above the hinge line, ribs about 20 in number, broad, low, and rounded, with interspaces about a quarter as wide, sometimes showing faint intercalary riblets or longitudinal striations; left valve usually slightly concave, sometimes strongly concave, with about 19 low, squarish ribs, about equal in width to the interspaces, sometimes longitudinally sulcated or ridged, interspaces flat-bottomed with usually a well-developed mid-rib, surface sculptured by fine concentric lines; hinge line about three-fifths the length of the shell, ears equal, those of the right valve convex, folded over, rectangularly truncated, byssal ear with two or three indistinct radiating ridges and concentric sculpture, other ears usually with concentric sculpture only.

Dimensions: Altitude, 98 mm.; length, 107 mm.; length of hinge, 58 mm.; convexity of right valve, 40 mm., concavity of left, 7 mm.

Type specimens: Of *vogdesi,* No. 14, of *heimi,* No. 46, in the type collection at Stanford University; of *cataractes,* in the British Museum ?.

Type localities: Of *vogdesi,* Pleistocene, lumber yard, San Pedro; of *heimi,* southern part of Arroyo San Gregorio, Lower California, Pliocene; of *cataractes,* living, Gulf of California.

Pliocene: 31st Street and Logan Avenue, San Diego (Sternberg Collection, 1924, specimen at Stanford University); San Diego Pliocene (Hemphill in Arnold, 1906); Cholas Valley, near San Diego (Stearns in Arnold, 1906); type locality of *heimi.*

Pleistocene: Type locality of *vogdesi;* Ventura Co. (Bowers in Arnold); San Diego (Hemphill in Arnold); Lower California (Hertlein).

Living: Gulf of California (Sowerby; Dall; Arnold; etc.).

This species is distinguished from *P. bellus* and its varieties (*hemphilli* being the closest) by its greater convexity, by the beak projecting beyond the hinge, and by its larger size. Comparison of the types of *heimi* and of *vogdesi* show them to be exactly the same. The writers first thought that *cataractes* could be distinguished as a variety by the mid-ribs of the left valve and by the narrower ribs of the right; but more specimens show that these distinctions will not hold.

Pecten (Janira) hartmanni Hertlein

Pecten (Pecten) hartmanni Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, pl. 1, figs. 4, 6, 1925.

Shell similar to that of *P. vogdesi* but still more convex and with only 16-17 broad, rounding ribs; shell somewhat narrower.

Type specimen: No. 48 in the type collection at Stanford University.

Pliocene: Arroyo Mesquital, Lower California, lower Pliocene (?).

Section EUVOLA Dall, 1898

Euvola Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 694, 1898.

Type (by original designation), *Ostrea ziczac* Linnæus, figured by Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 6, species 29, 1852, living, West Indies (according to Dall, which is probably correct).

Intermediate between *Janira* and *Amusium*, the shell with the arched right valve and flat (or concave) left valve of *Janira*, but with the ribs practically obsolete on the exterior, and with well-developed internal liræ as in *Amusium*.

Pecten (Janira) keepi Arnold

Pecten (Pecten) keepi Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 60, pl. 5, fig. 1, pl. 6, figs. 1, 1*a*, 1906.
? *Pecten (Pecten) refugioensis* Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 7, pl. 1, fig. 2, pl. 5, fig. 9, 1925.

Shell with the general form of *P. vogdesi*, but less convex and with the ribbing almost entirely obsolete; on the left valve ribs narrower than in *vogdesi* and the somewhat broader interspaces bounded by narrow grooves so that the interspaces are sometimes hard to distinguish from the ribs; sometimes the sculpture so nearly obsolete that it can hardly be made out at all except on the umbones; shell internally grooved almost as in *Amusium*.

Dimensions: Altitude, 75 mm.; length, about 75 mm.; length of hinge, 35 mm.; convexity of right valve, 21 mm.

Type specimens: Of *keepi*, No. 5, of *refugioensis*, No. 49, in the type collection at Stanford University.

Type localities: Of *keepi*, Carrizo Creek district, north of the Mexican boundary, Imperial Co.; of *refugioensis*, north of San Jose del Cabo, Lower California.

Pliocene or *upper Miocene:* Type locality of *refugioensis*.
Pliocene: Type locality of *keepi*.

This species, as Hertlein has already pointed out, is a link midway between *Janira* (formerly known as typical *Pecten*) and *Amusium*. It is close to, and is probably directly related to *P. ziczac* (Linnæus), a species living in the Caribbean region; but on the left valve of the latter the interspaces have been raised higher than the ribs (by contact with the internal grooves of the right valve), giving the sculpture a very peculiar appearance. The sculpture on the form *refugioensis* is a trifle weaker than that on the type of *P. keepi*; but as the two forms come from the same general region and have the same shape and the same sculpture pattern, the writers do not think the difference significant. A little more flattening of the right valve and bulging of the left would make this species an *Amusium*.

Subgenus **AMUSIUM** Bolten, 1798

Amusium Bolten, Mus. Boltenianum, p. 165, 1798, original list includes *Ostrea pleuronectes* and others; Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 12, p. 207, 1886; Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 691 (last paragraph), pp. 693, 698, 744, 755, 1898.

Amussium Bolten emended, Herrmannsen, Indicis Generum Malacozoorum, Vol. 1, p. 47, 1846.

Type (by subsequent designation, Herrmannsen, 1846), *Ostrea pleuronectes* Linnæus.[1]

Shell large, thin, almost flat, disc-like, valves nearly smooth exteriorly, occasionally with faint radial grooves representing the edges of the obsolete ribs; internally with strong, narrow radial liræ, often in pairs corresponding to the edges of the interspaces of the ribbed ancestor, also a pair of short internal ridges diverging from the shallow resilial pit toward the side margins; ears small, short, shaped as in *Janira*, with a nearly obsolete byssal notch.

Geologic range: Oligocene to Recent.

Distribution: Mainly Oriental, but Dall reports also a typical species in the Gulf of Mexico.

The transition from *Janira* to *Amusium* is very evident, being accomplished by the flattening of the right valve and the loss of the external ribs, with the compensating strengthening of the interior. The shape of the ears, as well as the existence of intermediate species, shows that *Amusium* is more closely allied to *Janira* than it is to any other group. Thus, although *Pecten* and *Amusium* have very dissimilar appearances, they are very closely allied genetically through *Janira*, and the writers are of the opinion that it would accomplish little to separate them generically, at least for the present. In other subgenera also, individual species have lost their external sculpture and developed internal liræ instead, as *P. pabloensis* and *P. hyalinus*, derivatives from *Aequipecten*.

The possibility of the transition may be seen in such forms as *P. stearnsii* variety *bakeri*, which has the general shape of *Amusium* but retains the external ribs and has not developed internal liræ. This form might be thought of as having gone a quarter of the distance from *Pecten* to *Amusium*. *P. keepi* has gone half the distance, retaining the arched right valve and flat left valve of *Janira*, but having lost external sculpture and developed internal liræ. *P. laurentii* has gone three-quarters of the distance, still having larger ears than typical *Amusium* and with the left valve almost flat but the right only slightly arched. Perhaps *P. keepi* has gone more than half way.

Pecten (Amusium) laurentii (Gmelin)

Ostrea laurentii Gmelin, in Linnæus, Syst. Nat., Ed. 13, p. 3317, 1790.

Pecten laurentii Gmelin, Sowerby, Thes. Conch., Vol. 1, p. 56, pl. 16, figs. 137, 138, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 16, species, 58, 1853.

"*Pecten* (*Amusium*) *lompocensis* Arnold," Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 92, in part, not the type, pl. 28, fig. 3, 1906.

? "*Pecten* (*Amusium*) *condoni* Hertlein," Hertlein, Bull. So. Calif. Acad. Sci., Vol. 24, p. 41, in part, unfigured paratype, 1925.

Shell of medium size, thin, nearly smooth exteriorly, right valve slightly arched, left valve almost flat; with about twenty pairs of moderately strong internal liræ, the pairs in the right valve being very close together; hinge line fully half as long as the shell, ears squarely terminated except the byssal ear, which has the byssal notch a little better developed than is usual for *Amusium*.

Dimensions: Altitude, 84 mm.; length, 87 mm.; length of hinge, 45 mm.; diameter, 18 mm.

Type locality: Living, China.

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[1] Schumacher, 1817, designates *A. japonicum* for *Amusium* Megerle von Mühlfeldt; but this change in type will not affect the use of *Amusium*. *A. japonicum* is included in Bolten's list.

Miocene: Four miles south of Lompoc, Santa Barbara County, California (Arnold); ? Montesano formation, upper Miocene, of Washington (Hertlein).
Living: China.

The ears, the internal ribbing, and the general shape of this species, which are all very characteristic, are shown in Arnold's figure of the California Miocene specimen. The writers feel that emphasizing the close relationship of the fossil to the living form is of much more significance than an attempt to separate them would be when no means are known by which to distinguish them.

Pecten (Amusium) pleuronectes (Linnæus)

Ostrea pleuronectes Linnæus, Syst. Nat., Ed. 10, p. 696, 1758.
Pecten cristatus Bronn, Ital. Tert. Gebilde, p. 116, 1831.
Pecten pleuronectes Linnæus, Sowerby, Thes. Conch., Vol. 1, p. 55, pl. 16, figs. 127, 128, 135, 136, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 13, species 48, 1853.
Pecten (Amusium) lompocensis Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 92 in part, pl. 28, figs. 1, 2 (right valves), not fig. 3, 1906; Arnold and Anderson, Bull. 322 U. S. Geol. Survey, p. 32, pl. 18, figs. 2, 3, 1907.

Shell of medium size, thin, nearly smooth externally, valves about equally convex; sculptured internally with 12 or 13 pairs of lirations, those in the right valve conspicuously paired, those in the left valve equally spaced so that the pairs are not evident; ears about two-fifths the length of the shell, small, somewhat obliquely terminated, byssal notch almost obsolete.

Dimensions: Altitude, 87 mm.; length, 87 mm.; length of hinge, 33 mm.; convexity of the two valves, 16 mm.

Type specimen: Of *lompocensis*, at the California Academy of Sciences (?).

Type localities: Of *pleuronectes*, East Indies, living; of *lompocensis*, Miocene 4 miles south of Lompoc, Santa Barbara Co., Calif.

Miocene: Lower Miocene between the Lower and Upper Ojai valleys, Ventura Co.; middle or upper Miocene (?), type locality of *lompocensis;* Italy (Bronn).
Living: East Indies and China.

The case of the synonymy of this species is just like the last. This species is distinguished from *laurentii* by its fewer pairs of liræ (each pair representing an obsolete rib), by the greater distance between the liræ in each pair, and by the smaller ears.

Pecten (Amusium) japonicus (Gmelin)

Ostrea japonica Gmelin, in Linnæus Syst. Nat., Ed. 13, p. 3317, 1790.
Pecten japonicus Gmelin, Sowerby, Thes. Conch., Vol. 1, p. 55, pl. 15, figs. 109, 110, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 12, species 47, 1852.
? Pecten mortoni Ravenel, Proc. Acad. Nat. Sci., Phila., Vol. 2, p. 96, 1844; Tuomey and Holmes, Pleiocene Fossils of South Carolina, p. 27, pl. 10, figs. 1, 2, 1855.
? "Amusium pleuronectes Linnæus," Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 12, pp. 208, 209, 1886; Vol. 18, p. 438, 1889.
? Pecten (Amusium) mortoni Ravenel, Glenn, Maryland Geol. Survey, Miocene Volume, p. 372, pl. 99, fig. 1, 1904.

Shell like that of *pleuronectes* but larger and with 18 to 24 pairs of internal liræ in each valve, the pairing not very distinct.

Dimensions: Altitude 110 mm.; length, 112 mm.; length of hinge, 39 mm.; convexity of right valve, 12 mm., of left valve, 9 mm.

? Miocene: Atlantic states (as *mortoni*).
Living: Japan; ? Gulf of Mexico (as *mortoni*).

Again we have two forms apparently the same in widely different localities. There can be no question but that the stock migrated between the two localities in the Miocene, passing probably through California; and if the species remained unchanged from the Miocene to the Recent in the Atlantic, there is no reason why it could not do the same in the Pacific.

Pecten (Amusium) condoni Hertlein

Pecten (*Amusium*) *condoni* Hertlein, Bull. So. Calif. Acad. Sci., Vol. 24, p. 41, pl. 4, figs. 8, 9, 1925.

Shell with the shape and size of *pleuronectes*, but showing on the surface apparently 17-18, very nearly obsolete, low, broad ribs, and with a byssal notch about as strong as that of *laurentii;* interior not known.

Dimensions: Altitude, 72 mm.; length, 72 mm.; length of hinge, 29 mm.; convexity of the two valves, 20 mm. (half in each).

Type specimen: No. 15 in the type collection at Stanford University.

U. Miocene: Montesano formation, Washington.

As species of this subgenus are distinguished principally by their interior ribbing, the status of this form is uncertain. It may be the same as *pleuronectes*, or possibly *P. obliteratus* (Linnæus)[1] from West Australia and China.

Subgenus **PROPEAMUSSIUM** de Gregorio, 1884

Propeamussium de Gregorio, "Nota intorno ad Alcune Nuove Conchiglie Miocenische di Sicilia," Il Naturalista Siciliano, Anno 3, no. 4, p. 119, January 1, 1884; Fischer, Man. Conchyl., p. 944, 1886, though the type cited, *Pecten inæquisculptus* Tiberi, is not in de Gregorio's original list; Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 122, 1930.

Propeamusium de Gregorio em., Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 12, p. 210, 1886; Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 698, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 50, 1906, type stated in all three references, *P. inæquisculptus* Tiberi = *fenestratus* Forbes.

Variamussium Sacco, Boll. Mus. Zool. ed Anat. Comp., R. Univ. Stud. Torino, Vol. 12, p. 101, June 11, 1897; I Molluschi dei Terreni Terziarii del Piemonte e della Liguria, Pt. 24, p. 49, 1897, type (by monotypy ?) *Pecten cancellatus* Schmidt, not Phillips, 1829, nor Goldfuss, 1833, nor Hall, 1843; Dautzenberg, Rés. Camp. Sci. Albert I, Prince de Monaco, Vol. 72, p. 271, 1927.

Not "*Propeamussium* de Gregorio," Cossmann and Peyrot, Actes de la Société Linnéenne de Bordeaux, Vol. 66, "Conchologie Néogénique de l'Aquitaine," Vol. 2, p. 305, August, 1914; Woodring, Carnegie Inst. Wash., Publ. No. 366, p. 74, 1925.

Type (by monotypy), *Pecten* (*Propeamussium*) *ceciliæ* de Gregorio, "Miocene" of Sicily.

Shell small, very thin, valves of approximately equal convexity, sculptured externally with concentric lines and sometimes on the left valve with radial striations, internally with a moderate number of raised liræ that in adult specimens often do not reach the periphery; hinge line of variable length, byssal ear sometimes with radial riblets, byssal notch moderately deep, narrow.

Geologic range: Cretaceous to Recent.

Distribution: Deep water, normally, but sometimes found in shallow; widely distributed.

It is unlikely that *Propeamussium* has any particular relation with *Amusium*. The byssal notch shows that it is probably more directly connected with *Chlamys* or *Aequipecten*.

Stewart has pointed out that Cossmann and Peyrot and later Woodring have raised the question of whether *P. ceciliæ* has the internal liræ of this group or not. However, Stewart concluded from a study of the original description that *ceciliæ* does have the internal liræ, and the present writers are inclined to believe that this view is correct. De Gregorio mentions nine broad, red-colored rays, presumably on the exterior. It seems hardly possible that the red color is the original color of the shell, if the Miocene age is correct. It is more probable that the shell had been stained by secondary oxide of iron, the stain affecting perhaps the parts of the surface that had once been ribs in an ancestral *Pecten*. If this is the case, these rays should be bordered by about 18 internal lirations of the sort described by de Gregorio (like so many thin, delicate sticks) in the interior of the shell. *Propeamussium* may be more closely allied to ribbed forms, like *Pecten pabloensis* or perhaps a *Janira*, than it is to *Pseudamussium*.

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[1] *Ostrea obliterata* Linnæus, Syst. Nat., Ed. 10, p. 697, 1758.

Pecten obliteratus Linnæus, Sowerby, Thes. Conch., Vol. 1, p. 55, pl. 16, fig. 126, 1842; Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 19, species 70, 1853.

For the sake of those who may find it difficult to consult the original reference to *Propeamussium*, a translation of de Gregorio's original description is given here in full:

NOTE ON SOME NEW MIOCENE SHELLS FROM SICILY

* * * * *

Propeamussium, new subgenus. I am proposing this subgenus for the species described below. Perhaps *P. semiradiatus* and *unguiculus* Mayer (in Hoffmann), etc., should also be referred to it.

Pecten (Propeamussium) ceciliæ de Gregorio. Shell extremely thin and compressed; with its internal and external surface polished. Diameter, 35 mm.; depth, 4 mm. The sculpture consists of very fine linear threads, concentric and radial; in the peripheral region these threads are almost completely cancellate, though some of the concentric lines are difficult to distinguish from lines of growth. The radial threads are distinct in the umbonal region.—More characteristic of this species are about 9 blood-colored red rays, rather wide, almost as wide as the interspaces. These rays do not project at all from the exterior, nor from the interior either, it would seem, if part of the umbonal region is, perchance, left out of consideration.—They are neither costæ nor mere colored zones; they affect the internal structure (cut the internal structure into strips) and they can be separated from the rest of the shell like so many thin, delicate sticks.

The right valve is barely convex, almost flat; the rays, though transparent, are firmly fixed to the inner part; they are to be found in the umbonal region and go as far as the middle, but without completely crossing it.

The left valve is even flatter; in fact, it is hardly at all convex in the umbonal region, and as for the rest, it is even a little concave, but that perhaps is due to the compression undergone during fossilization. The rays are much more marked and visible; they traverse not only the umbonal region, but also the middle.

It much resembles *Amussium lucidum* Jeffreys, from which it is distinguished by the colored zones and by the diverse sculpture, principally by the radiating threads.

My guide, V. Meneguzzo, found various fragments of this most interesting species and one specimen (though lacking the ears) in the Terrebianche region in a white foraminiferal marl which appears to me much like the one at Malta.

* * * * *

PALERMO, DECEMBER, 1883.

Section PROPEAMUSSIUM, s. s.

Shell with stronger radial sculpture on the exterior of the left valve, making the two valves noticeably discrepant, rarely with some radial striation on the exterior of the right valve also.

The species of this section from the Pacific coast of North America are very like species from other parts of the world, and in time some of them will probably be found to be conspecific. There are several species in the early Tertiary of the Pacific coast that should be assigned here. *P.* (*Propeamussium*) *interradiatus* Gabb is said to have come from the Eocene, though there is some reason to believe now that the type locality might have been in the Kreyenhagen shale, Oligocene. This species is large, having an altitude of 25 mm., the eight internal liræ of the left valve continuing only about half that distance; the ears are large, and the left valve has numerous radial striations. *P.* (*Propeamussium*) *waylandi* Arnold from the Clallam formation, middle Miocene of Washington and its probable synonym *P. stanfordensis* Arnold from the Miocene near Stanford University, middle California, are much like the young of *interradiatus* and may be found to be conspecific with that species also. They are distinguished only by smaller size and shorter hinge line. The "elevated ridges on the left valve" of *waylandi* look very much like the impressions of the internal ribbing and can be attributed to the state of preservation. *P.* (*Propeamussium*) *clallamensis* Arnold, which occurs with *waylandi*, is distinguished by the fewer, coarsely laminated radial ribs on the exterior of the left valve. All of these forms are figured and described by Arnold in his *Pecten* monograph, 1906.

Pecten (Propeamussium) alaskensis Dall

Pecten (*Pseudamusium ?*) *alaskensis* Dall, Amer. Journ. Conch., Vol. 7, p. 155, pl. 16, fig. 4, 1871.

Pecten (*Propeamusium*) *alaskensis* Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 12, p. 215, pl. 5, figs. 7, *7a*, 1886; Bull. 37 U. S. Nat. Mus., pl. 5, figs. 7, *7a*, 1889, 1903; Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 711, 1898; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 133, pl. 53, figs. 2, *2a*, 3, 1906; Dall, Bull. 112 U. S. Nat. Mus., p. 20, pl. 1, fig. 2, 1921; Oldroyd, Univ. Wash. Publ., Puget Sound Biol. Sta., Vol. 4, p. 20, pl. 27, fig. 6, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 62, pl. 12, fig. 3, pl. 38, fig. 6, 1924.

Not "*Pecten alaskensis* Dall," Whiteaves, Trans. Roy. Soc. Canada, Vol. 4, p. 119, 1887, = *P. vancouverensis* Whiteaves.

Pecten alaskensis Dall, Küster and Kobelt, Martini-Chemnitz Syst. Conch. Cab., Ser. 2, Vol. 17, Spondylus und Pecten, p. 245, pl. 64, figs. 7, 8, 1888; Newcombe, Bull. Nat. Hist. Soc. Brit. Columbia, p. 53, 1893.

Pecten (*Propeamusium*) *riversi* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 126, pl. 44, figs. 8, 9, 1906.

Pecten (*Propeamusium*) *levis* Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 56, pl. 2, figs. *2a-d*, 1916, not *Pecten lævis* Pennant, 1777, nor Defrance, 1825, nor Nilsson, 1827, nor Potiez and Michaud, 1844, etc.

Pecten calamitus Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 176, 1924, new name for *Pecten levis* Moody.

Shell small, thin, circular, with a short hinge line, right valve smooth externally except for growth lines, left valve sculptured with 18 or more fairly strong primary radial riblets and about as many more smaller intercalaries, the ribs finely laminated on specimens that have not lost the surface layer of the shell; interior of each valve with about 22 radiating liræ, which in the right valve are covered up from the center of the shell to the umbo by a deposit of chalky material, but which persist faintly to the umbo in the left valve if the chalky deposit has been worn off, though they are difficult to distinguish from the impressions of the external ribs, the number of the internal liræ often increased to 29-33 by the appearance of intercalaries in the widest interspaces.

Dimensions: Altitude, 17 mm.; length, 18 mm.; length of hinge, about 9 mm.; convexity of the two valves, 4 mm., the left slightly the more convex.

Type specimens: Of *alaskensis*, in the U. S. National Museum; of *riversi*, No. 33 in the type collection of Stanford University; of *calamitus*, No. 11,084 at the University of California.

Type localities: Of *alaskensis*, living, Alaska; of *riversi*, Santa Monica Canyon, Los Angeles Co.; of *calamitus*, Fourth and Broadway, Los Angeles.

Pliocene: Type locality of *calamitus*.

Pliocene or *Pleistocene:* Type locality of *riversi*.

Pleistocene: Lower San Pedro series of Deadman Island, San Pedro Harbor, Los Angeles Co. (Arnold); of Alaska (Dall); of Vancouver Island (Newcombe).

Living: Alaska to Magdalena Bay, Lower California, usually in deep water; Japan.

This species is easily distinguishable from the Miocene and older species on the Pacific coast by its more numerous internal lirations. The writers tried to distinguish *riversi* from the living *P. alaskensis* Dall on the basis of the still more numerous internal lirations on the living specimens, until they noticed that Dall's original description calls for only 21. The form renamed by Hanna is exactly like *riversi*. *P.* (*Propeamussium*) *davidsoni* Dall, a species living in Alaska, and apparently to be assigned to *Propeamussium* rather than to *Pseudamussium*, has much the same shape; but it has fewer and stronger external ribs on the left valve, and after it is a little more than half grown it develops ribs on the outside of the right valve also.[1]

Section Parvamussium Sacco, 1897

Parvamussium Sacco, Boll. Mus. Zool. ed. Anat. Comp., R. Univ. Stud. Torino, Vol. 12, p. 101, June 11, 1897; I. Molluschi dei Terreni Terziarii del Piemonte e della Liguria, Pt. 24, p. 48, 1897; Woodring, Carnegie Inst. Wash., Publ. No. 366, p. 74, 1925.

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[1] *Pecten davidsoni* Dall, Nautilus, Vol. 11, p. 86, 1897; Proc. U. S. Nat. Mus., Vol. 24, p. 559, pl. 40, figs. 5, 6, 1902; Keep, West. Amer. Shells, p. 41, figs. *21a*, *21b*, 1904.

Pecten (*Pseudamusium*) *davidsoni* Dall, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 138, pl. 50, figs. 4, *4a*, 1906; Dall, Bull. 112 U. S. Nat. Mus., p. 20, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 61, 1924.

Pecten (*Propeamusium*) *davidsoni* Dall, Moody, *loc. cit.*

Type (by original designation), *Pecten duodecim-lamellatus* Bronn, Italiens Tertiär Gebilde, p. 116, 1831, Miocene of Tabbiano, Italy. The original description of this species is:

"*P. testa subæquivalvis compressa, rotundata, eleganter et dense concentrice-striata, eradiata; auriculis æqualibus; intus lamellis 11-12, æque-distantibus, apice clavato-incrassatis radiata.*

"Verwandt mit *P. squamula* Lmk. VI. i. 83. Länge und Breite 7'''."

Without or with very weak radial striations on the exterior of the left valve.

Geologic range: Miocene of the West Indies (Woodring) to Recent.

Distribution: Deep water, typically, but sometimes found in shallow; widely distributed.

This section is closely related to the typical, there being intimate gradations between them. If *Propeamussium* should in any way be invalidated, *Parvamussium* would become the subgenus or genus and *Variamussium* would be a section.

Subgenus **PSEUDAMUSSIUM** Klein in Mörch, 1853

Pseudamusium Klein, Meth. Ostrac., p. 134, 1753 (pre-Linnæan), species included, *Pecten lævis variegatus*, etc.

Pseudamussium Klein, Mörch, Cat. Conch. Yoldi, Pt. 2, p. 59, 1853, original list includes *Pecten septemradiatum* Müller, under which is placed "*P. pseudamussium* Ch." as a synonym; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 553, 1858, original list contains *hybridus* Gmelin and a number of others, but *exoticus* Chemnitz and *lævis* Klein and *pseudamusium* Sowerby not mentioned by name; Stoliczka, Mem. Geol. Survey, India, Palæo. Indica., Vol. 3, p. 426, 1871, type designated: "*Pecten exoticus* Chemnitz (*Pseudamusium-Pecten lævis* etc., of Klein)."

"*Propeamussium* de Gregorio," Cossmann and Peyrot; Woodring; etc.; see *Propeamussium*.

Pseudamusium H. and A. Adams, Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 697, 1898.

Type (by tautonymy, and by subsequent designation, Stoliczka 1871), *Ostrea hybrida* Gmelin, in Linnæus, Syst. Nat., Ed. 13, p. 3318, 1790; + *Pseudamusium*, *Pecten lævis*, etc., Klein, Meth. Ostrac., p. 134, l. 9, fig. 31, 1753; "*Pseud-Amusium. Pecten lævis*," etc., Klein cited by Chemnitz, Neues Syst. Conch. Cab., Vol. 7, p. 298, but not pl. 63, figs. 601, 602, 1784; + *Pecten exoticus* Chemnitz, Vol. 11, p. 262, pl. 207, figs. 2037, 2038, 1795; + *Pecten pseudamusium* Sowerby, Thes. Conch., Vol. 1, p. 56, pl. 19, figs. 211, 212, pl. 20, fig. 243, 1842, also illustrated by Reeve, Conch. Icon., Vol. 8, *Pecten*, pl. 16, species 56, 1853.

Shell small, very thin, discoidal; sculptured with fine radial and concentric striations, sometimes with only the radial on the left valve and only the concentric on the right, when these lines are worn off showing only concentric waves; hinge line rather long, byssal ear sculptured with radial riblets, byssal notch deep; interior smooth.

Geologic range: Cretaceous to Recent (if *Camptonectes* is included, Jurassic to Recent).

Distribution: Practically world wide, more characteristic of deep water, but also found in shallow.

This subgenus looks very much like a primitive form that has lived on for a long time without changing much. It resembles somewhat the Palæozoic genus *Aviculopecten*, and it may be related to *Chlamys* and the other modern Pectens as an ancestor. It is distinguished from *Propeamussium* by its smooth interior. Some of the names that have been applied to closely related groups, a number of which should probably be considered synonyms or should be assigned to subordinate divisions, are: *Camptonectes* Agassiz in Meek, 1864, *Syncyclonema* Meek, *Eburneopecten* Conrad, 1865, *Pectinella*, *Hyalopecten*, *Cyclopecten*, Verrill, 1897, and possibly *Palliolum* Monterosato, 1884, and *Lissochlamys* Sacco, 1897.

Dall and others have stated that Klein had but a single species. The references by Mörch and by H. and A. Adams to Klein should make Klein's species available for type, no matter whether *Pseudamussium* is dated from Mörch or from the Adams brothers. Hence Woodring's objection[1] that *Pecten exoticus* Chemnitz and *Pecten pseudamusium* Sowerby are not named in the original list does not invalidate Stoliczka's designation, and we do not have to rely on Suter's designation in 1913 of *Pecten hybridus* (Gmelin), which would not be available for *Pseudamussium* Mörch. However, Stewart has pointed out[2] that Mörch cited under "*Pecten septemradiatum* Müller" "*P. pseudamussium* Ch." If *Pecten septemradiatus* Müller is taken as the type by absolute tautonymy, then *Pseudamussium* Mörch will have to be applied to *Peplum* and one of the other names noted above will have to be applied to this group, unless an earlier binomial use of *Pseudamussium* can be found. Stewart uses *Palliolum* and proposes a new subgenus, *Delectopecten*, for *vancouverensis*. On the other hand, if "*P. pseudamussium* Ch." determines Mörch's idea of the type of *Pseudamussium* by absolute tautonymy (as it clearly must), then *Pecten pseudamusium* Chemnitz must be taken into account as part of Mörch's type, if not the whole of it. Chemnitz' species is composite, for the reference to Klein clearly includes Klein's species, although the figures are apparently of *septemradiatus*. Hence the type of *Pseudamussium* as determined by tautonymy must be considered composite, and Stoliczka, being the first definitely to designate the type, fixed the name on Klein's species. It is clear that the early writers confused the two groups, and we have no right to say that Mörch meant to apply *Pseudamussium* exclusively to the *septemradiatus* group, in view of his reference to Klein. Although there is some question about whether this reasoning can be accepted, or must be accepted, or not, the rule is that in doubtful cases the long-established usage should be followed. Furthermore, Stoliczka's designation would probably apply to any earlier binomial use of Klein's name that may be found, and the present course would, in case such a use is found, avoid the necessity of changing the meaning of the name and later shifting it back again to its original meaning. The finding of an earlier binomial use is not at all unlikely, because Klein's names were well known among the early conchologists and many early sources, especially German and Italian, have not been investigated. Deshayes almost established the name,[3] but invalidated his application of it by stating that it was not adopted.

Pecten (Pseudamussium) pedroanus (Trask)

Plagiostoma pedroona Trask, Proc. Calif. Acad. Sci., Vol. 1, p. 93, pl. 3, figs. 1, 1*a*, 1856.

Plagiostoma truncata Trask, Proc. Calif. Acad. Sci., Vol. 1, p. 94, pl. 3, fig. 3, 1856.

Plagiostoma annulatus Trask, Proc. Calif. Acad. Sci., Vol. 1, p. 94, pl. 3, fig. 2, 1856.

Pecten peckhami Gabb, Geol. Survey Calif., Palæo, Vol. 2, p. 59, pl. 16, figs. 19, 19*a*, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 258, 1888; Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 705, 1898; ? Arnold. Bull. 396 U. S. Geol. Survey, p. 13, pl. 3, figs. 2, 2*a*, Jan. 15, 1910, reprinted in Bull. 398, pl. 25, figs. 2, 2*a*, 1910; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

Pecten pedroanus Trask, Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 60, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 258, 1888; Dall, Trans. Wagner Free Inst. Sci., Phila., Vol. 3, p. 705, 1898; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907.

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[1] Woodring, Carnegie Inst. Wash., Publ. No. 366, p. 72, 1925.

[2] Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 122, 1930.

[3] Deshayes, Ency. Méth., Vol. 3, p. 854, 1832.

Pecten randolphi Dall, Nautilus, Vol. 11, p. 86, 1897; Proc. U. S. Nat. Mus., Vol. 24, p. 559, pl. 40, fig. 2, 1902; Keep, West Amer. Shells, p. 41, 1904.

Pecten (Pseudamusium) peckhami Gabb, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 56, pl. 3, figs. 6, 7, 8, 1906; Proc. U. S. Nat. Mus., Vol. 32, pl. 44, fig. 3, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pl. 31, fig. 3, 1907; Dall, Prof. Paper 59 U. S. Geol. Survey, p. 113, 1909.

Pecten (Pseudamusium) pedroanus Trask, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 90, pl. 28, figs. 4, 5, 1906; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pl. 36, figs. 5, 6, 1907.

Pecten (Pseudamusium) randolphi Dall, Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 138, pl. 48, figs. 2, 2*a*, 1906; Dall, Bull. 112 U. S. Nat. Mus., p. 19, 1921; Oldroyd, Univ. Wash. Publ., Puget Sound Biol. Sta., Vol. 4, p. 19, pl. 4, fig. 8, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 59 (not pl. 14, figs. 5, 6 = *P. (Propeamussium) davidsoni*), 1924.

Pecten (Pseudamusium) randolphi Dall var. *tillamookensis* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 139, pl. 48, figs. 3, 3*a*, 1906.

Pecten pedroanus Arnold, McLaughlin and Waring, Map Folio accompanying Bull. 69 Calif. St. Mining Bureau, pl. 1, fig. 35, 1914.

Pecten (Pseudamusium) tillamookensis Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 20, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 59, 1924.

? Pecten vanwinkleæ Clark, Univ. Calif. Publ. Geol., Vol. 15, p. 82, pl. 15, fig. 2, 1925.

Shell small, transparent, discoidal, both valves sculptured with delicate radial striations and concentric lines that become slightly spinose at the intersections but are often entirely worn or dissolved off so that the surface of the shell is varied only by broad concentric waves; hinge line of variable length, the byssal ear sculptured with four or five fairly strong radial riblets, byssal notch moderately deep, leaving a scar about two-thirds as wide as the rest of the ear.

Dimensions (of a large living specimen): Altitude, 30 mm.; length, 30 mm.; length of hinge, 14 mm.; convexity of the two valves, 6 mm.

Type specimens: Of *randolphi*, No. 107,749, of *tillamookensis*, No. 150,233, in the U. S. National Museum.

Type localities: Of *pedroanus*, *truncatus*, and *annulatus* in the shales underlying the "Pliocene" and Pleistocene of San Pedro, probably Pliocene; of *peckhami*, in the bituminous shales probably of the Monterey formation, middle Miocene, of Sulphur Mt. south of the Ojai Valley, Ventura Co.; of *randolphi*, living off Destruction Island, Washington, in 516 fathoms; of *tillamookensis*, living off Tillamook Bay, Oregon, in 786 fathoms; of *vanwinkleæ*, Oligocene of Porter Creek, Washington.

? Eocene: Tejon formation of the Coalinga district (Arnold, 1910).
? Oligocene: As *P. vanwinkleæ*.
Miocene: Numerous localities, especially in the middle Miocene, the Monterey shale of California and the Clallam formation of Washington (Arnold, 1906).
Pliocene: Type locality of *pedroanus;* Puente Hills, Los Angeles Co. (Arnold); Third Street tunnel, Los Angeles, abundant (Arnold, 1907); near Eastlake Park, Los Angeles (McLaughlin and Waring).
Living: Bering Sea to Guaymas, Mexico (Dall, 1921).

The synonymy listed above is just another case of putting together closely related forms that exhibit no significant characters by which they can be separated. Attempts have been made to point out distinguishing characters, but the writers have seen nothing that did not appear to be due to individual variation or to the state of preservation (even in Recent forms the differences in preservation give individuals different appearances). There is little use in keeping forms separate until it is known how to separate them. If such forms are synonymized, there will be fewer workers misled into trying to use them as guide fossils.

Variety **pedroanus**, s. s.

Byssal ear comparatively narrow.

Pecten (Pseudamussium) pedroanus (Trask) variety **vancouverensis** Whiteaves

"*Pecten caurinus* Gould young," Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 12, p. 216, pl. 5, fig. 4, 1886, figure reprinted in Bull. 37 U. S. Nat. Mus., pl. 5, fig. 4, 1889, 1903.

"*Pecten* (*Pseudamusium*) *alaskensis* Dall," Whiteaves, Trans. Roy. Soc. Canada, Vol. 4, p. 119, 1887.

Pecten (*Pseudamusium*) *vancouverensis* Whiteaves, Ottawa Naturalist, Vol. 7 (Trans. Ottawa Field-Nat. Club, Vol. 9), p. 133, pl. 1, figs. 1, 1*a*, 1893; Newcombe, Bull. Nat. Hist. Soc. Brit. Columbia, p. 53, 1893; Taylor, Trans. Roy. Soc. Canada, Ser. 2, Vol. 1, p. 26, 1895; Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 140, pl. 52, figs. 3, 3*a*, 1906; Dall, Bull. 112 U. S. Nat. Mus., p. 20, pl. 1, figs. 4, 5, 1921; Oldroyd, Univ. Wash. Publ., Puget Sound Biol. Sta., Vol. 4, p. 20, pl. 4, fig. 7 (not fig. 8), 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 60, pl. 12, figs. 6, 7, 1924.

Pecten (*Pseudamusium*) *arces* Dall, Proc. U. S. Nat. Mus., Vol. 45, p. 592, 1913.

Pecten (*Pseudamusium*) *vancouverensis fernandoensis* Hertlein, Bull. So. Calif. Acad. Sci., Vol. 24, pl. 4, figs. 6, 7, 1925.

Like the typical variety but with the ventral submargin of the right valve sloping off more abruptly in a concave arc, leaving more room for the byssal notch and the broader byssal ear; the ventral ear of the left valve correspondingly deeper.

Type specimens: Of *vancouverensis*, at Ottawa (?); of *arces*, No. 267,169 in the U. S. National Museum; of *fernandoensis*, No. 16 in the type collection at Stanford University.

Type localities: Of *vancouverensis*, living off Vancouver Island; of *arces*, off Santa Barbara in 500 fathoms; of *fernandoensis*, on the Ventura River 1½ mi. north of Ventura, ¼ mi. south of Taylor well No. 1, Ventura Co., Calif.

Pliocene: Type locality of *fernandoensis;* also from well core, Long Beach, Calif. (Hertlein).
Living: Bering Sea to San Diego.

This variety is distinguished from the typical by its larger byssal ear. In the specimens from the Pliocene the distinction is not very definite, and it is probable that the variety first appeared at about the beginning of the Pliocene. The form described by Clark and Arnold as variety *sanjuanensis*[1] from the Sooke beds, lower Miocene or Oligocene of Vancouver Island, appears to be a *Propeamussium* close to *alaskensis* and may extend the range of that species into the older Tertiary. *P. lompicoensis* Arnold[2] (not to be confused with *lompocensis*) is another form assigned to *Pseudamussium* that is more probably a *Propeamussium*, though it is poorly preserved and it is difficult to be sure. The latter appears to belong to the *P. interradiatus* group, and it may be a synonym of that species.

Dall has described, but not figured, two other supposed species of *Pseudamussium* from San Diego.[3] Another supposed species described by Dall was renamed *binominatus* by Hanna.[4]

Family LIMIDAE

Shell equivalve, auriculate, gaping, Pectiniform, with one adductor muscle; shell substance fibrous, with minute tubules, not pearly or prismatic; hinge without teeth, or with traces of taxodont armature; hinge area extending on both sides of beaks, equal in both valves; ligament external, resilium sub-internal; byssus generally present. (After Dall.)

Geologic range: Carboniferous to Recent.

Distribution: World wide.

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[1] *Pecten* (*Pseudamusium*) *vancouverensis* Whiteaves subspecies *sanjuanensis* Clark and Arnold, Univ. Calif. Publ. Geol., Vol. 14, p. 140, pl. 16, figs. 5, 6, 1923, type specimen No. 224 at Stanford University.

[2] *Pecten* (*Pseudamusium*) *lompicoensis* Arnold, Prof. Paper 47 U. S. Geol. Survey, p. 89, pl. 23, fig. 5, pl. 27, fig. 8, 1906.

[3] *Pseudamusium incongruum* Dall, *Pseudamusium bistriatum* Dall, Proc. U. S. Nat. Mus., Vol. 52, pp. 403, 404, 1916.

[4] *Pecten* (*Pseudamusium*) *andersoni* Dall, Sci. Res. Canadian Arctic Exped., Vol. 8, p. 19A, pl. 2, figs. 7, 8, 1918, not *Pecten* (*Aequipecten*) *andersoni* Arnold, 1906.

Pecten binominatus Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 175, 1924.

Genus LIMA Bruguière, 1797

Lima Brugière, Encycl. Méth. (Tabl. Vers), pl. 206, 1797, name and figure only; Cuvier, Tabl. Elém. Hist. Nat. Anim., p. 421, 1798; Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 88, 1799; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 309, 1897; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 765, 1898; Woodring, Carnegie Inst., Publ. No. 366, p. 79, 1925.

Type (by absolute tautonymy, Cuvier, 1798), *Ostrea lima* Linnæus, Syst. Nat., Ed. 10, p. 699, 1758; figured by Bruguière in the Ency. Méth., pl. 206, fig. 4, 1797, and described by Deshayes in Ency. Méth., Vol. 3, p. 345, 1832; also figured by Sowerby in Reeve's Conch. Icon., Vol. 18, *Lima*, sp. 10, pl. 2, fig. 10, 1872, as *L. squamosa* Lamarck, Indo-Pacific, Recent.

Shell equivalve, compressed, ovate, oblique, slightly inflated; ornamented with radiating costæ, which may be simple or scaly; umbones prominent, auriculate, small lateral appendages unequal; cardinal area triangular, having a central pit for the ligament; hinge without teeth; muscle impressions large. (Harris.)

This genus is abundantly represented in the Mesozoic. Several species have been reported from the early Tertiary of the Pacific coast and three in the Pliocene and Pleistocene deposits.

Lima tetrica Gould

Lima tetrica Gould, Proc. Boston Soc. Nat. Hist., Vol. 4, p. 93, 1851; Boston Jour. Nat. Hist., Vol. 6, p. 405, pl. 16, fig. 6, 1857; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 535, 583, 621, 1863.

Radula tetrica Gould, Lamy, Jour. de Conchyl., Vol. 57, p. 214, 1909.

Type locality: La Paz, Gulf of California, Mexico.

Pleistocene: Upper Pleistocene of coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Lower California to Panama, Galapagos and Juan Fernandez Islands.

This is a small, moderately oblique species which appears to be related to *L. angulata* Sowerby.[1]

Lima dehiscens Conrad

Lima dehiscens Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 247, pl. 19, fig. 7, 1837; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 245, 1888; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 769, 1898; Dall, in Orcutt, West American Scientist, Vol. 19, No. 3,[2] p. 23, 1921.

"*Lima orientalis* Adams and Reeve," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 645, 1864; Keep, West Coast Shells, p. 168, fig. 142, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 193, 1892; not of Adams and Reeve, *fide* Arnold, 1903.

Lima (*Mantellum*) *dehiscens* Conrad, Dall, U. S. Nat. Mus., Bull. 112, p. 20, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 63, 1924.

Pliocene: Santa Barbara (Cooper).
Pleistocene: Lower San Pedro series of Deadman Island, one specimen (Arnold); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Dall, in Orcutt).
Recent: Monterey, California, to Acapulco, Mexico (Dall, 1921).

Lima hamlini Dall

Lima hamlini Dall, Nautilus, Vol. 14, p. 16, 1900; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; Dall, Vol. 66, Art. 17, p. 18, pl. 29, fig. 6, 1925.

Type locality: Third Street tunnel, Los Angeles; Pliocene.

Pliocene: Pliocene clays of Los Angeles City (Dall; Arnold).

The single imperfect specimen is well figured by Dall (1925).

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[1] Thes. Conch., *Lima*, sp. 12, figs. 39, 40, 1843; Conch. Icon., Vol. 18, *Lima*, sp. 13, pl. 3, fig. 13, 1872.

[2] Vol. 19, No. 3, is dated June 15, 1921; Vol. 21 is dated 1919!

Superfamily Anomiacea

Family ANOMIIDAE

Shell variable, often rather flat, sometimes pearly and thin; in most genera the right valve with a foramen, through which passes the calcified or horny plug; resilium internal; hinge usually edentulous or rugose.

Genus ANOMIA Linnæus, 1758

Anomia Linnæus, Syst. Nat., Ed. 10, p. 700, 1758; Children, Quart. Jour. Sci., Lit., Arts, p. 46 (pl. 2, fig. 97), April, 1823; Meek, U. S. Geol. Surv. Territories, Vol. 9, p. 21, 1876; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 774, 781, 1898.

Type (by subsequent designation, Children, 1823), *Anomia ephippium* Linnæus, Syst. Nat., Ed. 10, p. 701, 1758.

Shell thin, attached, with a calcified byssal plug passing through a sinus in the right valve; two byssal scars present; hinge edentulous.

Geologic range: Jurassic to Recent (Meek).

Distribution: Cosmopolitan.

Pododesmus differs in having a single conspicuous byssal scar. *Placunanomia* is large, heavy shelled, its byssal foramen is entirely closed except in the young, and its hinge is armed.

Anomia peruviana d'Orbigny

Plate 12, Figures 2, 5

Anomia peruviana d'Orbigny, Voy. Amer. Mérid., Vol. 5, pt. 3, Moll., p. 673, 1846; Philippi, Abbild. Beschreib. Conchyl., Vol. 3, p. 131, pl. 1, fig. 2, 1850; Dall, Proc. U. S. Nat. Mus., Vol. 37, pp. 148, 257, pl. 28, fig. 4, 1909; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 26, pl. 3, fig. 3, 1920; Dall, Bull. 112 U. S. Nat. Mus., p. 21, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 65, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; E. K. Jordan and Hertlein, p. 417, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Anomia lampe Gray, Proc. Zool. Soc. London for Jan.-June, 1850, p. 117; Reeve, Conch. Icon., Vol. 11, *Anomia*, pl. 4, figs. 16*a-b*, 1859; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Museum, p. 167, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, p. 646, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 106, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 229, 1888; Keep, West Coast Shells, p. 163, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 194, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 785, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 117, 1903; Lamy, Journ. Conchyl., Vol. 57, pp. 224, 225, 1909.

Anomia limatula Dall, Proc. U. S. Nat. Mus., Vol. 1, p. 15, 1879; Trans. Wagner Inst. Sci., Vol. 3, p. 785, pl. 35, fig. 19, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 118, 1903.

Anomia simplex Mabille, Bull. Soc. Philom., Paris, Ser. 8, Vol. 7, p. 73. 1895.

Pliocene: Turtle Bay, Lower California, Mexico (Jordan and Hertlein).

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, "rare"; common in upper San Pedro series of San Pedro, Los Cerritos (Signal Hill), Long Beach, and Crawfish George's; Pleistocene of Barlow's Ranch, near Ventura, and of Spanish Bight and Pacific Beach, San Diego (Arnold, as *A. lampe*); Pleistocene of Coronado Beach (Dall, 1879, as *A. limatula*); Twenty-sixth Street, San Diego (Arnold, 1903, as *A. limatula*); "Saugus" formation near Ventura (Waterfall, 1929, as *A. peruviana*); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: San Pedro, California, to Peru and the Galapagos Islands (Dall, 1921).

This is the common Recent *Anomia* of the Pacific coast. It is variable in shape and general appearance due to the influence of situs. Generally it is thin and partly translucent with irregular sculpture, sometimes almost smooth. *A. limatula* Dall is based upon a slightly heavier and smoother specimen, but it appears to be within the limits of specific variation of the Recent form.

Anomia subcostata Conrad

Anomia subcostata Conrad, U. S. House of Representatives, Doc. No. 129, p. 15, July, 1855; U. S. Pacific R. R. Repts. Vol. 5, p. 325, pl. 5, fig. 34, 1856; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 785, 1898; Kew, Univ. Calif. Publ. Geol., Vol. 8, p. 46, 1914; G. D. Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 460, pl. 23, figs. 3-5, 1926.

Type specimen: In the U. S. National Museum.

Type locality: Coyote Mountain, Imperial County; Pliocene.

Pliocene: Carrizo (= Imperial) formation, lower division, several localities, and in the upper division at Carrizo Valley and Yuha Buttes, western Imperial County, California (Kew).

This species, described by Conrad from the "Miocene" on Carrizo Creek, Colorado Desert, has strong radial sculpture. Its relationship to other Pacific coast species has not been studied.

Genus PODODESMUS Philippi, 1837

Pododesmus Philippi, Wiegmann's Arch. f. Naturg. for 1837, p. 385, pl. 9, fig. 1, (1837 ?); Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 770, 779, 1898.

Type (by monotypy), *P. decipiens* Philippi = *Placunanomia rudis* Broderip, Cuba, Recent.

Shell variable, right valve rather flat, suborbicular, somewhat pearly; byssal plug passing through foramen in right valve; a single conspicuous byssal scar present; hinge without teeth; valves sculptured with radial grooves.

This genus lacks the cardinal crura of *Placunanomia* Broderip. The open byssal foramen of *Pododesmus* is a further distinguishing character. *Anomia* Linnæus with the two byssal scars and thinner shell is quite distinct.

Section Monia Gray, 1849

Monia Gray, Proc. Zool. Soc. London, for 1849, p. 121, 1850; Bucquoy, Dautzenberg and Dollfus, Moll. Marins du Roussillon, Vol. 2, fasc. 2, p. 41, August, 1888; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 771, 774, 1898.

Type (by subsequent designation, Bucquoy, Dautzenberg and Dollfus, 1888), *Anomia zealandica* Gray, in Dieffenbach's New Zealand, p. 261, 1843; figured by Reeve, Conch. Icon., Vol. 11, *Placunanomia*, sp. 4, pl. 1, fig. 4, 1859, habitat New Zealand.

Shell ovate, not plicated; radiately ribbed; perforation of lower valve large, only slightly embracing the large thin plug. (Gray, 1849.)

Monia Gray is much like *Pododesmus, s. s.*, but has a larger byssal opening.

Pododesmus macroschisma (Deshayes)

Plate 12, Figures 3, *4a*, *4b*

Anomia macroschisma Deshayes, Rev. Zool. Soc. Couverienne, p. 359, 1839; Guerin's Mag. Zool., pl. 34, 1841; Middendorff, Beitr. Mal. Rossica, Vol. 3, p. 6, 1849; Philippi, Abbild. Beschreib., Vol. 3, *Anomia*, p. 132, pl. 1, fig. 4, 1850.

Placunanomia macroschisma Gray, Proc. Zool. Soc. London, for 1849, p. 121, 1849; Cat. Anom. Brit. Mus., p. 11, 1850; Reeve, Conch. Icon., Vol. 11, *Placunanomia*, sp. 7, pl. 2, fig. 7, 1859; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 646, 1864; Tryon, Struct. Syst. Conch., Vol. 3, p. 294, pl. 131, fig. 76, 1884; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 260, 1888; Keep, West Coast Shells, p. 163, fig. 137, 1888, 1892.

Placunanomia cepio Gray, Proc. Zool. Soc. London, for 1849, p. 121, 1849; Cat. Anom. Brit. Mus., p. 11, 1850; Reeve, Conch. Icon., Vol. 11, *Placunanomia*, sp. 12, pl. 3, figs. 12*a*-*b*, 1859.

Placunanomia alope Gray, Proc. Zool. Soc. London, for 1849, p. 122, 1849; Reeve, Conch. Icon., Vol. 11, *Placunanomia*, sp. 11, pl. 3, figs. 11*a*-*b*, 1859.

Placunanomia macroschisma Deshayes, Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 297, 1874.

Placunanomia (*Monia*) *macroschisma* Deshayes, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 194, 1892.

Pododesmus (*Monia*) *macroschisma* Deshayes, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 780, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 116, 1893; Dall, Bull. 112 U. S. Nat. Mus., p. 21, 1921; I. S. Oldroyd, Univ. Washington Publ. Puget Sound Biol. Sta., Vol. 4, p. 23, pl. 35, figs. 1*a*-*b*, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Monia macroschisma Deshayes, Dall, Amer. Jour. Sci., Ser. 4, Vol. 23 (whole No. 173), p. 457, 1907; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, p. 25, 1907; Arnold and R. Anderson, U. S. Geol. Surv., Bull. 322, p. 59, 1907; Berry, Nautilus, Vol. 22, p. 38, 1908; Arnold, U. S. Geol. Surv., Bull. 396, pp. 24, 25, 27, 75, 134, pl. 14, fig. 1, Jan. 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 36, fig. 1, 1910; Dall in Moffit, Bull. 533, p. 45, 1913; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 219, 1917; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 26, pl. 3, figs. 1, 2, 1920.

Pododesmus macroschismus Deshayes, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 148, 1924.

Pododesmus macroschisma Deshayes, Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 65, pl. 26, figs. 1*a*-*b*, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In British Museum ?.

Type locality: Kamchatka, *fide* Oldroyd, 1924.

Pliocene: Lower and upper Etchegoin of Coalinga district (Arnold; Nomland); Fernando Pliocene of Santa Maria district, Santa Barbara County (Arnold and R. Anderson); middle Fernando of Elsmere Canyon, Los Angeles County (Eldridge and Arnold, 1907); Pico formation near Ventura (Waterfall); San Diego well, Balboa Park, San Diego (Dall, 1874); S. D. S. N. H., loc. 218, uppermost Pico, east of South Mountain, Ventura County; Otter Creek and Center, also second beach east of Nome, Alaska, supposedly Pliocene (Dall, in Moffit, 1913); Santa Barbara formation, upper Pliocene, at Bath-house Beach, Santa Barbara (Berry).

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Jordan, 1924); Tomales Bay, Marin County (Dickerson); rare in the upper San Pedro series of San Pedro, Crawfish George's. and Deadman Island (Arnold, 1903); S. D. S. N. H. loc. 233, ridge north of Arroyo Santa Rosa, Ventura County (U. S. G. collector); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1926); ?Pleistocene of Alaska (see below).

Recent: Southern Bering Sea from the Pribilof Islands to Japan and the Okhotsk Sea on the west, and on the east south to and including the whole coast of Lower California, Mexico (Dall, 1921).

This is the common *Pododesmus* of the Pacific coast. It is generally larger, heavier shelled, and has coarser radial sculpture than *Anomia peruviana*. It also has but one byssal scar. The occurrences in Alaska were attributed by Dall in the papers above cited to the Pliocene, but may be in part Pleistocene. It occurs at least as low as the Jacalitos formation, lower Pliocene, and is probably descended from *Pododesmus newcombei* Clark and Arnold,[1] from the upper Oligocene or lower Miocene of Vancouver Island. This latter species appears to be smaller and more coarsely and evenly sculptured, the radial ribs being separated by wider interspaces.

Genus PLACUNANOMIA Broderip, 1832

Placunanomia Broderip, Proc. Zool. Soc. London, pp. 28, 29, 1832; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 770, 771, 1898.

"Placunomia" Swainson, Treat. Malac., p. 390, 1840, "Abridged from *Placunanomia* Sow."; Woodward, Man. Mollusca, pt. 2, p. 255, 1854.

Type (by monotypy), *Placunanomia cumingii* Broderip, Central American and west Mexican coasts, Recent.

Shell with interlocking rugosities on the cardinal margins of the valves; right valve with two prominent elevated ridges converging acutely at the cardinal margin and fitting into a corresponding bipartite socket in the left valve; right valve with one prominent subcentral adductor scar and about half way between it and the lower ends of the crura the closed (in adult) byssal foramen is equally prominent; left valve with the conspicuous adductor and byssal scars adjacent; inner surface of both valves somewhat pearly; valves with few strong, subangular plications.

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[1] Univ. Calif. Publ. Geol., Vol. 14, p. 141, pl. 21, figs. 3-6, 1923.

This genus is very different from *Anomia* and *Pododesmus* as noted on preceding pages. *Pododesmus macrochisma* Deshayes has been referred to *Placunanomia* probably because of Stoliczka's citing this species as type.

Placunanomia cumingii Broderip

Placunanomia cumingii Broderip, Proc. Zool. Soc. London, Pt. 2, p. 29, 1832; Reeve, Conch. Icon., Vol. 11, *Placunanomia*, pl. 1, figs. *3a-b*, 1859; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, pp. 215, 216, pl. 23, fig. 4, 1926.

Type locality: Gulf of Dulce, Costa Rica, Recent.

Pliocene: In the cliffs about one mile south of the village, Maria Madra Island, Mexico.
Recent: Gulf of California, Mexico, to Gulf of Dulce, Costa Rica.

This species, the type of the genus, is characterized by the few strong, subangular plications and the lack of radial striations.

Placunanomia californica Arnold

Placunanomia californica Arnold, U. S. Geol. Surv., Bull. 396, p. 75, pl. 24, figs. 2, *2a*, 3, Jan. 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 46, figs. 2, *2a*, 3, 1910.

Type specimen: U. S. National Museum, No. 165,546.

Type locality: South of Kettleman Hills, Sec. 10, T. 25 S., R. 19 E., Mt. Diablo B. and M., Coalinga district, Pliocene.

Pliocene: Upper portion of the Etchegoin formation at the type locality, Coalinga district, rare (Arnold).

This rare species differs from *P. cumingii* in the presence of radial riblets and the very low, almost obsolete plications. *P. hannibali* Jordan and Hertlein is very closely related, but has finer radial sculpture and the byssal scar is not sub-triangular as in Arnold's species.

Placunanomia hannibali Jordan and Hertlein

Placunanomia hannibali E. K. Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, pp. 443, 444, pl. 28, figs. 2-4, 1926.

Type specimen: California Academy of Sciences, No. 2,110.

Type locality: Southeast of Turtle Bay, Lower California, Mexico; upper Pliocene.

Pliocene: At the type locality (Jordan and Hertlein).

This species is closely related to *P. californica* Arnold, but the radial sculpture is much finer. It appears to attain a larger size and the byssal scar does not have the subtriangular shape of the type of *californica*. Numerous specimens were obtained at the type locality.

When more specimens of this species and *californica* become available for study, it may be necessary to reduce *hannibali* to varietal or synonymic status.

Superfamily Mytilacea

Family MYTILIDAE

Shell equivalve, ovate or elongate; umbones anterior; hinge edentulous or with small or obscure teeth; ligament internal or submarginal; byssus generally present; inner shell layer sometimes nacreous or subnacreous; pallial line entire.

Genus MYTILUS Linnæus, 1758

Mytilus Linnæus, Syst. Nat., Ed. 10, p. 704, 1758; Children, Quart. Jour. Sci., Lit., Arts, Vol. 15, p. 33 (pl. 1, fig. 79), April, 1823; Gray, Proc. Zool. Soc. London for 1847, p. 198, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 785-787, 1898; Jukes-Browne, Proc. Malac. Soc. London, Vol. 6, p. 217, 1905.

Not *Mytilus* Linnæus, as restricted by Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 107, 1817.

Type (by subsequent designation, Gray, 1847, see below), *Mytilus edulis* Linnæus, cosmopolitan.

Shell elongate, rather thin; beaks terminal, pointed; generally wider and rounded behind, and with a slight byssal gape; sculpture consisting of concentric undulations, and sometimes radial ribs, which may be wide and indefinite or fine and uniform; epidermis present, often dark; interior of shell with a thin nacreous layer; hinge edentulous or with a few small teeth.

Geologic range: Mesozoic to Recent.

Distribution: Cosmopolitan.

We retain the Linnæan name *Mytilus* for the shells so well known under this designation in spite of Schumacher's citation of the "figure of the hinge of" *Anodonta anatina* (*Mytilus anatinus* Linnæus) as the type of the genus. To follow Schumacher would make *Mytilus* the valid name for *Anodonta* Bruguière; but as it undoubtedly will be but a matter of time before the International Commission suspends the rules in favor of retaining *Mytilus* in its generally accepted sense, it would merely cause confusion to transfer *Mytilus* to the fresh-water Anodontas in the interim. There might be some doubt in regard to the manner in which Schumacher cites the type, but a special ruling should settle the matter permanently.

Subgenus **MYTILUS**, s. s.

Umbonal end of shell not greatly thickened.

Section Mytilus, s. s.

Sculpture when present consisting of incremental undulations and coarse, often indefinite or subdued radial ribs, sculpture sometimes lacking; fine bifurcating riblets absent.

Mytilus (Mytilus) edulis Linnæus

Mytilus edulis Linnæus, Syst. Nat., Ed. 10, p. 705, 1758; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 252, 1888; Bucquoy, Dautzenberg and Dollfus, Moll. Mar. Roussillon, Vol. 2, fasc. 4, pp. 136-143, pl. 26, figs. 1-4, 1890; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 118, 119, 1903; Thompson, Rept. Brit. Columbia Commissioner of Fisheries for 1912, p. I-40, pls. 7, 11, 1913; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, pp. 46, 47, 1913; Dall, Canadian Arctic Exped., Vol. 8, Pt. A, p. 28A, 1919; Weymouth, Calif. Fish and Game Comm., Bull. No. 4, p. 27, pl. 3, fig. 4, 1920; U. S. Nat. Mus., Bull. 112, p. 21, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 66, pl. 27, fig. 4, 1924.

Mytilus pedroanus Conrad, U. S. House of Representatives, Document No. 129, p. 15, July, 1855 (reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 167, 1909); U. S. Pacific R. R. Repts., Vol. 5, p. 325, pl. 5, fig. 40, 1856.

Mytilus ficus Dall, U. S. Geol. Surv., Prof. Paper 59, p. 113, pl. 9, figs. 1, 4, 1909; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922.

Miocene: ?.

Pliocene: Submarine beach west of Snake River; of Center Creek; of submarine beach west of Nome, and second beach one and a half miles east of Nome, all Alaska (Dall, 1913); Empire formation of Coos Bay, Oregon (as *M. ficus* Dall); Pliocene of the Red Crag, England, etc.

Pleistocene: South Side of Bernard Harbor, northern Canada; mouth of Inman River; Dolphin and Union Strait, Northwest Territories (Dall, 1919); Benecia, Solano County (Cooper); lower San Pedro series of Deadman Island, rare; upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro (Arnold); Atlantic coast, etc.

Recent: Arctic Ocean to San Diego; cosmopolitan in temperate waters.

This species is too well known to need description. A large series of specimens from many different localities exhibits variations which, in shape, include a large number of supposed species described from the Pacific coast Tertiary. The references and data on occurrence given above are much abbreviated. The earliest occurrence of *M. edulis* on the Pacific coast may be in the lower Miocene, where it is represented by *Mytilus sammamishensis* and *M. snohomishensis* Weaver (Wash. Geol. Surv., Bull. 15, pp. 58, 59, 1912), two Blakeley formation forms which are probably one and the same species and either conspecific with *edulis* or its ancestor. *M. stillaguamishensis* Weaver was unfigured and the description suggests no valid characters by which to distinguish it from the other two forms from apparently the same horizon.

Mytilus (Mytilus) californianus Conrad

Plate 12, Figure 6

Mytilus californianus Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 242, pl. 18, fig. 15, 1837; Reeve, Conch. Icon., Vol. 10, *Mytilus*, pl. 1, figs. 2*a*-*b*, 1858; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 26, pl. 4, figs. 1, 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 21, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 66, pl. 27, fig. 2, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 3, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Shell ovate elongated, inflated; anterior margin straight; posterior side emarginate; ribs not very numerous, slightly prominent, broad, rounded; lines of growth very prominent. Length, 2⅛ inches. (Conrad.)

Type locality: San Diego, California.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, "part of one valve" (T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Unalaska, Aleutian Islands, eastward and southward to Socorro Island, Mexico (Dall).

This common large *Mytilus* of the Recent California fauna is characterized by its few, obscure, rather broad radial riblets.

Section Hormomya Mörch, 1853

Hormomya Mörch, Cat. Yoldi, fasc. 2, p. 53, 1853.

"*Brachydontes* Swains.," Gray, Proc. Zool. Soc. London for 1847, p. 199, 1847, type *Mytilus exustus.*

Type (here designated), *M. exustus* Linnæus.

Shell sculptured with numerous, fine, closely spaced, bifurcating riblets.

The type of this section has a distinctive sculpture of numerous, small, bifurcating ribs which are quite different from the broad, unequally developed ribs on such species as *M. californicus.* The section is poorly represented on the Pacific coast, *M. adamsianus* Dunker (Proc. Zool. Soc., 1856, p. 360) being the only native California Recent species.

Gray associated this group with *Brachidontes*, although the latter has a slightly produced, Volselloid, anterior margin. To judge by a few Recent specimens from Florida, the two groups come very close to intergrading, and it is not unlikely that the separation is artificial. Perhaps *Brachidontes* should be recognized as a genus intermediate between *Mytilus* and *Volsella*, with *Hormomya* as a section.

Subgenus **MYTILOCONCHA** Conrad, 1862

Mytiloconcha Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 14, p. 290, 1862; Dall, Trans. Wagner. Inst. Sci., Vol. 3, p. 787, 1898.

Type (by subsequent designation, Dall, 1898), *M. incurvus* Conrad, Fossils of the Medial Tertiary of the United States, No. 1, cover page 3, 1838, No. 2, pp. 52, 53, pl. 28, fig. 1, 1840 (text and figures republished by Wagner Free Inst. Sci., 1893), Miocene of Maryland.

Shell curved, thick; beaks pointed, somewhat divergent distally, and greatly thickened internally, with a ridge and a long furrow or groove for the cartilage.

Conrad originally described the type species under *Myoconcha* Sowerby,[1] a Jurassic genus having considerable similarity. Later he proposed *Mytiloconcha* for the Maryland Miocene shell, which is adopted for *M. coalingensis* Arnold and such other Pacific coast species as may prove upon examination to have the peculiar heavy terminal hinge of the type. Conrad's later spelling *Mytiliconcha* is inadmissible.

Mytilus (Mytiloconcha) coalingensis Arnold

Mytilus (*Mytiloconcha*) *coalingensis* Arnold, U. S. Geol. Surv., Bull. 396, p. 73, pl. 19, fig. 5, pl. 22, fig. 6, Jan. 15, 1910; Bull. 398, pl. 41, fig. 5, pl. 44, fig. 6, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, 1915.
Mytilus coalingensis Arnold, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 252, 1916; Nomland, Vol. 10, p. 219, 1917.

Type specimen: U. S. National Museum, Cat. No. 165,551.

Type locality: Coalinga region, California, Etchegoin, middle Pliocene.

? Miocene: ? Upper San Pablo, upper Miocene, questionably as a new variety (Clark).
Pliocene: Etchegoin formation of Coalinga region (Arnold); common in the *Pecten coalingensis* zone, Coalinga region, also questionably in the *Turritella nova* zone (Nomland); Etchegoin, and Merced of the Sargent oil field, near Sargent, Santa Clara County (Martin).

This species has the greatly thickened terminal hinge characteristic of typical *Mytiloconcha*. It differs from *M.* (*Mytiloconcha*) *incurvus* Conrad in being larger, broader, and in having a prominent muscle pit just anterior to the beaks.

Mytilus trampasensis Clark[2] of the upper Miocene has been considered a *Mytiloconcha*, but we are not aware that the hinge has been examined. This species is probably conspecific with *M. perrini* Clark from the same formation. *M. mathewsonii* Gabb is a typical *Mytilus* and is more closely related to *M. edulis* than to *M. incurvus*.

The subgeneric position of the following species is unknown to us.

Mytilus kewi Nomland

Mytilus kewi Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 206, pl. 9, fig. 1, 1916; Vol. 10, pp. 299, 300, 304, pl. 14, fig. 1, 1917; not *M. kewi* Wiedey, Journ. Paleo., Vol. 3, p. 281, pl. 31, fig. 2, 1929, = *M. loeli* Grant, Journ. Paleo., Vol. 4, p. 419, 1930.

Type specimen: In the collection of the University of California.

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[1] Min. Conch. Gt. Britain, Vol. 5, p. 103, pl. 467, 1825, *Myoconcha crassa* Sowerby, monotype, from the Ironshot Oolite near Bristol.

[2] Univ. Calif. Publ. Geol., Vol. 8, pp. 457, 458, pl. 42, figs. 2, 3, 1915.

Type locality: On Jacalitos and Waltham Creeks, Fresno County, Etchegoin, lower Pliocene.

Miocene: Santa Margarita formation, upper Miocene, north of Coalinga, also from the Santa Margarita formation on the Nacimiento River, several miles west of San Miguel, San Luis Obispo County (Nomland, 1917).

Pliocene: Lower and middle Etchegoin, lower and middle Pliocene, Coalinga region (Nomland, 1916).

M. kewi Nomland was stated to be smaller than *M. coalingensis* Arnold with less acute and thickened beak. It also has a depression extending from beak to basal margin.

Mytilus middendorffi Grewingk

Mytilus middendorffi Grewingk, Verhandlungen der Russisch-Kaiserlichen Mineralogischen Gesellschaft zu St. Petersburg, Jahrgang 1848 and 1849, No. 6, pp. 167, 171, 360, pl. 7, figs. 3*a-c*, 1850; Dall, 17th Ann. Rept. U. S. Geol. Surv., Pt. 1, p. 844, 1896; Dall, Harriman Alaska Series, Vol. 4, p. 113, 1904, reissued by Smithsonian Inst., 1910.

Miocene: Unga Island and Kadiak Island, near Cape Tonki, Igatskoi Bay, Alaska (Grewingk; Dall).

This species differs from all other Pacific coast Neocene and Quaternary species in the broad plications on the distal portions of the valves. Dall has given its occurrence in Alaska as Miocene.[1] In the geology volume of the Harriman Alaska report Dall states that this species is represented in the Pliocene of Oregon by *Mytilus condoni* Dall, but we have found no description of this latter species. Perhaps it is the species which Dall later called *Mytilus ficus,* although that form as figured is not similar to Grewingk's figure of *middendorffi.* Unless *condoni* has been actually described, it must be considered a *nomen nudum.*

Genus **SEPTIFER** Recluz, 1848

Septifer Recluz, Rev. Zool., p. 275, 1848; Stoliczka, Pal. Indica, Cret. Pelecypoda So. India, p. 366, 1871; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 328, 1897.

Type (*fide* Stoliczka, 1871), *Mytilus bilocularis* Linnæus.

Shell like that of *Mytilus,* but with an umbonal deck.

Septifer bifurcatus (Conrad)

Mytilus bifurcatus Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 241, pl. 18, fig. 14, 1837; Reeve, Conch. Icon., Vol. 10, *Mytilus,* pl. 9, fig. 41, 1851; Williamson, Nautilus, Vol. 12, pp. 67, 68, 1898.

Septifer bifurcatus Reeve, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 101, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 264, 1888; Keep, West Coast Shells, p. 171, fig. 144, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 191, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 789, 1898; Keep, West American Shells, p. 33, fig. 15, 1904; E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2, 1919.

Septifer bifurcatus Conrad, Pilsbry and Raymond, Nautilus, Vol. 12, pp. 69, 70, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 119, 1903.

Septifer bifurcatus (Conrad) Reeve, Dall, Bull. 112, U. S. Nat. Mus., p. 21, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 67, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925.

Shell narrowed, slightly arcuate; anterior margin much flattened; ribs narrow, prominent, bifurcating toward the base; color dark purple. Height 1½ inches. (Conrad.)

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[1] Eichwald, p. 128, 1871, attributes this species to the Cretaceous and identifies it with *Modiola dufrenoyi* d'Orbigny from the Senonian, U. Cretaceous of Europe. See the note on *Mya arenaria* variety *profundior*, p. 414.

Pleistocene: San Pedro series of Deadman Island, rare (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); Pleistocene at San Diego (Mrs. K. Stephens, MS.); Pleistocene of the Chiton bed, Point Firmin, Los Angeles County (E. P. and E. M. Chace); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).

Recent: Crescent City, California, to Gulf of California, Mexico (Dall).

Septifer margaritanus Nomland

Septifer margaritana Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 308, 309, pl. 19, fig. 5, 1917.

Type specimen: University of California collection, No. 11,310.

Type locality: Santa Margarita beds about ten miles northeast of Coalinga.

Miocene: Type locality.

This species is larger and has more numerous radial ribs than *S. bifurcatus*, and the umbonal ridge is more marked. Neither the description nor the figure throw light on the presence or absence of an umbonal deck, and we have not seen specimens.

Genus VOLSELLA Scopoli, 1777

(*Modiolus* Lamarck, 1799)

Volsella Scopoli, Introd. Hist. Nat., p. 397, 1777; Gray, Proc. Zool. Soc. London, for 1847, p. 198, 1847; Meek, U. S. Geol. Surv. Territories, Vol. 9, pp. 69-71, 1876; Bucquoy, Dautzenberg and Dollfus, Moll. Mar. Roussillon, Vol. 2, fasc. 4, p. 150, 1890; Jukes-Browne, Jour. Conchology, Vol. 11, p. 101, 1904; Dautzenberg and Fischer, Hirondelle et Princesse Alice Rept., p. 366, 1912.

Modiolus Lamarck, Mém. Soc. Hist. Nat. Paris, p. 87, 1799; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 790, 791, 1898.

Modiola Lamarck, Syst. Anim. s. Vert., p. 113, 1801; Bucquoy, Dautzenberg and Dollfus, Moll. Marins Roussillon, Vol. 2, fasc. 4, p. 150, 1890; Jukes-Browne, Proc. Malac. Soc. London, Vol. 6, p. 221, 1905.

Type (by subsequent designation, Gray, 1847), *Mytilus modiolus* Linnæus, European seas, Recent.

Shell obliquely oblong, expanded posteriorly and inflated along an oblique medial line from the umbonal end to the posterior ventral margin; anterior end produced beyond umbones; hinge edentulous in adult.

In Scopoli's rare work, "Introductio ad Historiam Naturalem," a copy of which is at hand, the name *Volsella* is proposed for a genus of supposedly denticulate *Mytilidæ*, the first species of which is *Mytilus modiolus* Linnæus, described as having one tooth. The second species, "*Gula soricis*" of Lister, is unknown to us, and the third and only remaining species is "*Mytilus l'aber*" of Adanson. The last species is figured by its author in his work on Senegal in such a manner that the hinge characters are indeterminable, but Scopoli attributes to it "dentibus pluribus." It is therefore evident from Scopoli's text[1] that his inclusion of *Mytilus modiolus* Linnæus in this group was due to some misconception of the hinge characters of his first species, but as the generic name in all respects fulfills nomenclatorial requirements and antedates Lamarck's *Modiolus*, it must be used in place of the latter. *Volsella* Scopoli is not a homonym of *Vulsella* Bolten.

Volsella has been divided into several minor groups, some of which appear natural, while others are clearly artificial. The species listed below belong to the typical subgenus, unless otherwise noted.

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[1] *Volsella, Pteria, Solen, Mya,* and other genera are placed under a heading "Cardine dendato." Scopoli might have been referring to the young of *Volsella*, which sometimes show traces of taxodont teeth.

Volsella modiolus (Linnæus)

Mytilus modiolus Linnæus, Syst. Nat., Ed. 10, p. 706, 1758; Chemnitz, Neues Syst. Conch. Cab., Vol. 8, p. 178, pl. 85, fig. 757, 1785.
Modiola modiolus Linnæus, Reeve, Conch. Icon., Vol. 10, *Modiola*, pl. 1, fig. 2, 1858; Clessin, in Martini und Chemnitz, Conch. Cab., Ed. 2, *Mytilidæ*, p. 92, pl. 5, fig. 3, 1889; Lamy, Jour. Conchyl., Vol. 57, p. 229, 1909.
Modiolus modiolus Lamarck, E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2 (p. 42), 1919.
Modiolus modiolus Linnæus, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 596, 1913; Dall, U. S. Nat. Mus., Bull. 112, p. 21, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 68, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 153, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the collection of the Linnæan Society of London?

Pliocene: Elk River formation, upper Pliocene, north of mouth of Elk River, Port Orford, Oregon (Arnold and Hannibal); lower San Pedro fauna of Nob Hill, San Pedro (T. S. Oldroyd).
Pleistocene: Pleistocene of the Chiton bed, Point Firmin, near San Pedro (E. P. and E. M. Chace); upper Quaternary at San Quintin Bay, Lower California, Mexico (E. K. Jordan).
Recent: On the Pacific coast from the Arctic Ocean to San Ignacio Lagoon, Lower California, Mexico (E. K. Jordan); circumboreal.

V. modiolus (Linnæus) is characterized by its rather blunt umbonal end, with the shell but little produced beyond the end of the beaks. The valves are rather broad (deep), being alate dorsally. The sculpture consists entirely of incremental lines. Living specimens have a dark brown or chestnut colored glistening epidermis. *V. capax* (Conrad), which is closely related, is similar in appearance, but has a much heavier shell, is often larger, and is more inflated along the line running obliquely from the umbones to the posterior part of the valves. In consequence of this greater inflation of the valves of *capax*, the dorsal area between the umbones is more depressed. *V. capax* generally has a rougher, partly hirsute epidermis.

V. modiolus has an imposing list of synonyms which are omitted here to conserve space.

Volsella capax (Conrad)

Modiola capax Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 242, 1837; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 121, 1857; Reeve, Conch. Icon., Vol. 10, *Modiola*, pl. 3, fig. 11, 1859; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 146, 1894; Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 73, 1895.
Modiolus capax Conrad, Clark, Univ. Calif. Publ. Geol., Vol. 8, table opp. p. 408, p. 418, 1914; Dall. U. S. Nat. Mus., Bull. 112, p. 22, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 69, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: At the Academy of Natural Sciences, Philadelphia?.

Type locality: San Diego, California; Recent.

Miocene: Santa Margarita formation and upper San Pablo of middle California (Clark).
Pliocene: Etchegoin formation of middle California (Clark); Pico formation, upper Pliocene, near Ventura (Waterfall).
Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, "one valve" (T. S. Oldroyd).
Recent: Santa Barbara, California, to Payta, Peru (Dall, 1921).

This species is similar to *V. modiolus*, but is heavier shelled, more inflated, and has a more depressed region between the umbones.

Volsella recta (Conrad)

Modiola recta Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 243, pl. 19, fig. 1, 1837; Reeve, Conch. Icon., Vol. 10. *Modiola*, pl. 7, fig. 38, 1857; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 643, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 101, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 251, 1888; Keep, West Coast Shells, p. 171, fig. 145, 1888, 1892.

Modiolus rectus Conrad, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 793, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 120, 121, 1903; Keep, West American Shells, p. 34, fig. 16, 1904; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 526, 1907; Arnold, Bull. 396, U. S. Geol. Surv., p. 146, pl. 20, fig. 4, Jan. 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 42, fig. 4, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, no. 212, pp. 588, 590, 596, 1913; Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 203, 1916; Martin, Vol. 9, p. 252, 1916; Nomland, Vol. 10, p. 211, 1917; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 27, pl. 4, fig. 3, 1920; Dall, Bull. 112, U. S. Nat. Mus., p. 22, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 68, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Modiolus directus Dall, U. S. Geol. Surv., Prof. Paper 59, p. 113, pl. 12, figs. 11, 12, 1909; Weaver, Washington Geol. Surv., Bull. 15, p. 18, 1912; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 588, 590 (including *directus* Dall), 596, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 418, 1915; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 28, 1916; Van Winkle, Univ. Wash. Publ. Geol., Vol. 1, no. 2, p. 75, 1918.

? Oligocene: Blakeley formation, Oligocene or lower Miocene of the Chahalis Valley, Washington (Van Winkle).

Miocene: Miocene of the basal sandstone, foot of 19th Street, Astoria, Oregon, and of the massive sandstone in the sea cliffs at Pillar Point near Clallam Bay, Washington (Arnold and Hannibal); Empire formation of the Coos Bay, Cape Blanco district, southwestern Oregon (Arnold and Hannibal; Dall, 1909; Howe; etc.); Montesano formation (Weaver); upper San Pablo formation of middle California (Clark, 1908); Miocene of El Toro ranch, Monterey County; Foxin's, Santa Barbara County (Cooper); Santa Margarita formation of middle California (Nomland, 1917).

Pliocene: Lower Pliocene on Jacalitos and Waltham Creeks, Coalinga district (Nomland); common in the *Chione elsmerensis*, *Turritella nova*, and *Pecten coalingensis* zones, and rare in the *Mya japonica* zone of the Etchegoin formation in the Coalinga district (Nomland, 1917); lower Pliocene of Elsmere Canyon, Los Angeles County (Arnold, 1907); Santa Rosa; Twelve Mile House, San Mateo County; Soquel, Santa Cruz County; San Fernando, Los Angeles County; San Diego well, Balboa Park, San Diego (Cooper, 1888); Pacific Beach, San Diego County (Arnold); Purisima of Santa Clara County; lower Merced formation; Merced of the Sargent oil field, near Sargent, Santa Clara County; Merced of Bolinas Bay and of Año Nuevo Bay (Martin); Pico, upper Pliocene part, near Ventura (Waterfall); Santa Barbara formation, upper Pliocene at Bathhouse Beach, Santa Barbara (Arnold).

Pleistocene: Rare in lower San Pedro series of Deadman Island (Arnold, 1903); Post-Pliocene of Santa Barbara (Cooper); Barlow Canyon, Ventura County (Arnold, 1903); Pleistocene at Pacific Beach and at foot of 26th Street, San Diego (Arnold, 1903; Mrs. Kate Stephens MS.); upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan).

Recent: Bolinas Bay, California, to Magdalena Bay, Lower California, Mexico (Dall, 1921); [variety *flabellata*, Vancouver Island to San Diego.]

This species differs from *V. modiolus* (Linnæus) in the greater extension beyond the beaks of the anterior alation; also the anterior half of the dorsal margin of the valves is straighter, the dorsal alation occurring posterior to the middle. *V. recta* attains a larger size and is often more elongate than *V. modiolus*.

Volsella recta Conrad occurs at least as early as the lower Miocene. The *Modiolus directus* of Dall appears to us to be conspecific with Conrad's species. The amount of alation beyond the beaks is variable; and this part of the shell margin, being rather thin and vulnerable, is subject to shortening by erosion.

Volsella recta (Conrad) variety **flabellata** (Gould)

Plate 12, Figure 7

Mytilus (Modiola) flabellatus Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 343, Dec., 1850; U. S. Expl. Exped., Vol. 12, p. 453, 1852, Mollusca Atlas, pl. 40, figs. 561, 561*a*, 1856.

Modiolus flabellatus Gould, Dall, Bull. 112 U. S. Nat. Mus., p. 22, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 68, pl. 6, fig. 2, 1924.

Type locality: Puget Sound; Recent.

Pleistocene: Las Posas zone, lower Pleistocene, S. D. S. N. H. loc. 241*a*, float just east of Harmon Canyon, Ventura County (coll. by U. S. G.).

Recent: Vancouver Island to San Diego, California (Dall, 1921).

This form is close to *recta*, but is larger, less ventricose, particularly at the umbones, and the anterior alation projects farther forward. It frequently dwells buried in mud with just a portion of the shell projecting. It is probable that some of the fossil records of *V. recta* refer to this variety, variation, or gerontic form.

Volsella fornicata (Carpenter)

Modiola fornicata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 643, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 179, 1865; Keep, West Coast Shells, p. 173, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 191, 1892.

Modiolus fornicatus Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 120, 1903; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 219, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 22, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 69, 1924.

Type specimen: In the collection of Mrs. Boyce, Utica, N. Y., *fide* Oldroyd.

Type locality: Santa Barbara, California; Recent.

Pliocene: Rare in the *Pecten coalingensis* zone, upper Pliocene part of the Etchegoin formation, Coalinga region (Nomland); Santa Barbara formation, upper Pliocene, at Bath-house Beach, Santa Barbara (Arnold).

Pleistocene: Rare in lower San Pedro series of Deadman Island, Los Angeles County; "Saugus" formation of Barlow Canyon, just east of Ventura (Arnold); lower Quaternary of Magdalena Bay, Lower California, Mexico (E. K. Jordan); upper San Pedro series of Los Cerritos (Arnold).

Recent: Trinidad to San Pedro and Cortez bank off San Diego, California (Dall).

In this species the beaks curve strongly forward, downward and backward so that a portion of their curve projects considerably beyond the anterior margins of the valves. In the Oldroyd Collection at Stanford University there is a Recent specimen from Monterey which is unusually large and swollen; it has the following measurements: extreme anterior-posterior length, 32 mm.; dorsal-ventral height, 16½ mm.; thickness of both matched valves together 20 mm. *Volsella trinominata* is much larger, does not have such a pronounced curvature of the umbones, is less ventricose, and is broader posteriorly. *Volsella fornicata* (Carpenter) may not belong to the typical section of the genus.

Volsella trinominata (Hanna)

Modiolus inflatus Dall, U. S. Geol. Surv., Prof. Paper 59, p. 114, pl. 12, figs. 8, 9, 1909; Weaver, Washington Geol. Surv., Bull. 15, p. 18, 1912.

Modiolus trinominata G. Dallas Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 171, March 18, 1924, new name for *Modiolus inflatus* Dall, not *Modiolus inflatus* (Tuomey and Holmes) Pleiocene Fossils of South Carolina, p. 33, pl. 14, fig. 3, 1855, as *Mytilus;* nor *Modiola (Lithodomus ?) inflata* Whitfield, U. S. Geol. Surv., Monogr. 9, p. 197, pl. 26, figs. 1, 2, 1885.

Type specimen: U. S. National Museum No. 153,946.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Coos Bay, Oregon (Dall); Blakeley formation, probably lower Miocene, western Washington (Weaver).

This species is said to be less alate and angulate dorsally than *capax*, and more evenly convex anteriorly. Howe considered it a synonym of *fornicata* (Carpenter), but Dall's figure of "*inflatus*" is so different from specimens of Carpenter's species that we do not believe the two species to be conspecific. The beaks of *Volsella fornicata* are strongly curved so that they project forward, downward, then backward, and a part of them porjects considerably beyond the actual anterior margin of the valves. Posteriorly, *fornicata* is narrower than "*inflatus*" and the entire shell is much smaller.

Subgenus **BRACHIDONTES** Swainson, 1840

Brachidontes Swainson, Treat. Malac., p. 384, 1840.
Not "*Brachydontes* Swains.," Gray, Proc. Zool. Soc. London, for 1847, p. 199, 1847, type *Mytilus exustus*.

Type (by monotypy), *Modiola sulcata* Lamarck, Indian Ocean; Recent; figured by Reeve, Conch. Icon., Vol. 10, *Modiola*, pl. 10, fig. 74, 1858.

Like *Volsella, s. s.*, but with numerous, well-defined radial riblets; shell generally of medium or small size.

Gray altered the original spelling to *Brachydontes*, which is inadmissible. His designation of *Mytilus exustus* as type is not valid, as that species was not in Swainson's original list.

Volsella (Brachidontes) stalderi (Martin)

Modiolus stalderi Martin, Univ. Calif. Publ. Geol., Vol. 8, pp. 182, 183, pl. 22, figs. 6*a*-*b*, August 6, 1914.

Type specimen: In the University of California collections.

Type locality: Near Ferndale, Humboldt County, California; Pliocene.

Pliocene: In the sea cliff at the mouth of a small gulch one-third of a mile north of the mouth of Guthrie Creek, about eight miles southwest of Ferndale, Humboldt County, the type locality (Martin).

This species differs from the Recent *Brachidontes demissus* (Dillwyn), which has been introduced into San Francisco Bay from the Atlantic on seed oysters, in being less pointed anteriorly and less incurved ventrally. It unquestionably belongs to *Brachidontes* Swainson.

Genus BOTULA Mörch, 1853

Botula Mörch, Catalogus Conchyl. Yoldi, fasc. 2, p. 55, 1853; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 792, 1898.

Type (by subsequent designation, Dall), *Botula fusca* (Gmelin).[1]

Shell long, subcylindric or rhombic; beaks subterminal or subcentral.

Section ADULA H. and A. Adams, 1857

Adula H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 517, Dec., 1857; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 799, 1898.

Type (by monotypy), *Botula* (*Adula*) *soleniformis* (d'Orbigny).

Shell rhombic, with subcentral beaks; surface of valves polished, not incrusted.

Botula falcata (Gould)

Lithodomus falcatus Gould, Proc. Boston Soc. Nat. Hist., Vol. 4, p. 92, 1851.
Adula falcata Gould, Keep, West Coast Shells, p. 170, fig. 143, 1888, 1892.
Botula falcata Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 22, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 71, pl. 21, figs. 8; 9, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925.

Type locality: Monterey, California; Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, California (T. S. Oldroyd).
Recent: Coos Bay, Oregon, to San Diego, California (Dall).

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[1] Mörch included but two specifically named species in his original generic list, the second being *fusca* (Gmelin), under which Mörch gives as a synonym "*Modiola cinnamomea* var. Lam."

This species is similar to *B. californiensis* Philippi, 1847, but is larger, more elongate, and the valves are sculptured with peculiar vertical striations. *B. diegensis* Dall[1] is still smaller and much broader. Mr. A. M. Strong points out that the latter species is probably a *Volsella;* it is not a rock borer.

Genus LITHOPHAGA Bolten, 1798

Lithophaga J. F. Bolten, Mus. Boltenianum, p. 156, 1798.
Lithodomus Cuvier, Le Régne Animal, Vol. 2, p. 471, 1817.

Type (by monotypy), *L. mytuloides* Bolten = *Mytilus lithophagus* Gmelin.

Shell elongate, sub-cylindrical, inflated anteriorly and wedge shaped posteriorly.

The wedge-shaped posterior end of the shell serves to differentiate this genus from *Botula.*

Section LITHOPHAGA, s. s.

Beaks nearly terminal; surface polished, without calcareous incrustation.

Section DIBERUS Dall, 1898

Diberus Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 799, 1898.

Type (by original designation), *L. plumula* Hanley.

Shell with two or more radial sulci extending backward from the beaks; with a plume-like incrustation arranged in a distinct pattern on the areas between the sulci, and when projecting beyond the ends of the valves, opposed symmetrically.

Myoforceps Fischer, 1886, is similar, but the incrustation projecting beyond the ends of the valves is twisted.

Lithophaga plumula (Hanley)

Lithodomus plumula Hanley, Proc. Zool. Soc. London, for 1844, p. 17, 1844; Reeve, Conch. Icon., Vol. 10, *Lithodomus*, pl. 4, fig. 23, 1857; Lamy, Jour. Conchyl., Vol. 57, p. 229, 1909.

Lithophagus plumula Hanley, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 125, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, p. 644, 1864; Keep, West Coast Shells, p. 171, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 192, 1892.

Lithophaga plumula Hanley, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 799, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 121, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 23, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 73, 1924.

Type locality: Panama; Recent.

Pleistocene: Upper San Pedro series at Los Cerritos (Signal Hill), Los Angeles County (Arnold).
Recent: Monterey, California, to Patagonia; also Atlantic.

The peculiar, coarsely and irregularly grooved incrustation serves to distinguish this species. It is the common rock borer of the southern California coast, being abundant in favorable localities.

Genus MODIOLARIA Beck, 1838

Musculus Bolten, Museum Boltenianum, Part 2, pp. 156, 157, 1798, not *Musculus* Martyn, Universal Conchologist, Vol. 4, explanatory table of plates 151 and 152, 1787; not *Musculus* Rafinesque, 1818, nor Mörch, 1853.

Modiolaria Beck, in E. Robert, Zool. Voy. Récherche en Isl. et en Grönl., pl. 17, figs. 1-4, 1838; Lovén, Ind. Moll. Scand., p. 33, 1846; Stoliczka, Mem. Geol. Surv. India, Palæo. Indica, Vol. 3, p. 368, 1871; Tryon, Struct. Syst. Conch., Vol. 3, p. 264, 1884; Bucquoy, Dautzenberg and Dollfus, Moll. Mar. Roussillon, Vol. 2, fasc. 4, p. 163, 1890; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 804, 1898.

"*Lanistes* Humph." Swainson, Treat. Malac., pt. 2, p. 385, 1840, not *Lanistes* Montfort, Conch. Syst., Vol. 2, genus 122, 1810.

Modiolarca J. E. Gray, Synop. Cont. Brit. Mus., Ed. 42, p. 151, 1840, misprint for *Modiolaria*, *fide* Sherborn, Index Animalium, Sect. 2, p. 4122, Aug., 1928.

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[1] Nautilus, Vol. 24, p. 10, 1911, figured in U. S. Nat. Mus., Bull. 112, pl. 1, figs. 1, 3, 1921.

Type (*fide* Stoliczka, 1871), *Mytilus discors* Linnæus, figured by Reeve, Conch. Icon., Vol. 10, *Modiolus*, pl. 9, fig. 65, 1857.

Shell rhomboidal, sculptured by two rows (one on each side of a lateral area) of striæ, which radiate from the beaks, leaving the middle portion smooth; umbones incurved, hinge edentulous or crenulated, with the hinge plate finely notched.

Musculus Bolten being preoccupied by Thomas Martyn, *Modiolaria* Beck takes its place. There is some doubt as to the year of issue of Beck's portion of the report of the Commission Scientifique d'Islande et de Grönland: Sherborn dates the genus 1838, while Bucquoy, Dautzenberg and Dollfus state that it appeared in 1846, the same year as Lovén's Index of the Mollusks of Scandinavia, in which, likewise, *Modiolaria* is proposed. *Lanistes* cannot date from Humphrey,[1] 1797, and Swainson's use of that name is later than Montfort, 1810.

A specimen of *Modiolaria lævigata* (Gray) is illustrated herewith, plate 12, figure 8.

Modiolaria nigra (Gray)

Modiola nigra J. E. Gray, Appendix Parry's Voy. 1819-20, p. ccxliv (*nomen nudem*), 1824; Beck, Voy. de la Récherche, pl. 17, fig. 1, 1851.

Modiolaria nigra Gray, Dall, 17th Ann. Rept. U. S. Geol. Surv., Part 1, p. 844, 1896; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 74, pl. 13, fig. 21, pl. 39, fig. 9, 1924.

Musculus niger Gray, Dall, U. S. Nat. Mus., Bull. 112, p. 23, 1921.

Miocene: Unga Island, Alaska (Dall, 1896).
Recent: Arctic Ocean to Oregon; circumboreal (Dall, 1921).

The fossil occurrence on Unga Island, Alaska, was attributed by Dall to the Miocene. The age determination of late Tertiary faunas in extreme northern provinces is often difficult, and in the present case it is possible that the Unga Island occurrence is of Pliocene age.

Genus **CRENELLA** Brown, 1827

Crenella T. Brown, Ill. Conch. Gt. Britain, Vol. 1, pl. 31, figs. 12-14, 1827; Ed. 2, p. 75, pl. 23, figs. 12-14, 1844; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 329, 1897; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 801, 802, 1898.

Type (probably by monotypy[2]), *Mytilus decussatus* Montagu, 1808.

Shell oval, or rhomboidal, surface ornamented by longitudinal and concentric striæ; umbones incurved; cardinal border denticulate, the denticles appearing to be the continuation of the crenulations on the margin of the valves; the single denticle present is also crenulated; interior of the valves nacreous. (Harris.)

Crenella decussata (Montagu)

Mytilus decussatus Montagu, Testacea Britannica, Supplement, p. 69, 1808.

Crenella decussata Montagu, Forbes and Hanley, Hist. Brit. Moll., Vol. 2, p. 210, pl. 45, fig. 2, 1853; Dall, U. S. Nat. Mus., Bull. 112, p. 24, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 79, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925.

Type locality: Scottish coast; Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd).
Recent: Bering Sea to Puget Sound and south to San Pedro, California; also Atlantic.

This is a minute shell with delicate radial striations. It is of infrequent occurrence as a fossil. *C. divaricata* d'Orbigny is probably a tropical race of this species.

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[1] Humphrey's genera are not accepted; moreover Sherborn states (Index Animalium, section 1, p. 518) that he cannot find that word in Humphrey's work.

[2] The first edition of Brown's "Illustrated Conchology of Great Britain" has not been available. The second edition contains only one species under *Crenella*, *M. decussatus*, under which reference is made to the first edition. For generic synonymy, see Dall, *op. cit.*, pp. 801-802, 1898.

ORDER ANOMALODESMACEA

Superfamily Laternulacea (=Ensiphonia Dall)

Family PERIPLOMATIDAE

Shell subnacreous, conspicuously inequivalve, nearly closed, edentulous; the resilium internal, between two anteriorly or vertically directed chondrophores, often buttressed, the lithodesma rarely wanting; ligament and area absent; the beaks fissured, the pallial sinus broad and shallow. Animal with the siphons separated to their bases, naked and wholly retractile. (Dall.)

Genus PERIPLOMA Schumacher, 1817

Periploma Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 115, 116, pl. 5, fig. 1, 1817.

Type (by monotypy), *Periploma inæquivalvis* Schumacher, *op. cit.*, p. 116, pl. 5, fig. 1, 1817.

Shell oval or rounded; surface smooth or with faint growth lines; lithodesma present.

This is a small genus of inequivalved shells. *Cochlodesma* Couthouy,[1] a genus of small, smooth, fragile shells, differs in its lack of the lithodesma. Both *Periploma* and *Cochlodesma* have the chondrophore buttressed posteriorly.

Periploma planiuscula Sowerby

Plate 13, Figures 1*a*, 1*b*

Periploma planiuscula Sowerby, Proc. Zool. Soc. London for 1834, p. 87, 1834; Stearns, Proc. U. S. Nat. Mus., Vol. 13, pp. 223, 224, 1890; Williamson, Vol. 15, p. 184, 1892; Dall, Vol. 49, p. 447, 1915; Dall, U. S. Nat. Mus., Bull. 112, p. 24, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 82, pl. 22, fig. 1, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Periploma lenticularis Sowerby, Proc. Zool. Soc. London, p. 87, 1834.

Periploma argentaria Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 238, pl. 18, fig. 8, 1837; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 638, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 258, 1888; Keep, West Coast Shells, p. 204, fig. 175, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 121, 122, 1903; Nomland, Univ. Calif. Publ. Geol., Vol. 10, table opp. p. 230, 1917.

Periploma obtusa Hanley, Illustr. Lamarck's Shells, pl. 2, fig. 50, 1842.

Anatina alta C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., Vol. 5, p. 294 (pagination of the separate), 1852.

Periploma exeurva Carpenter, Proc. Zool. Soc. London for 1855, p. 229.

Periploma excurvata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 287, 1857 (error for *exeurva*).

Shell ovate, thin, with incremental striæ, and on the posterior portion of the valves obscure radial sulci; right valve more ventricose than left; chondrophore ovate-trigonal, its longer diameter directed forward obliquely and reinforced posteriorly by an elongate rib-like buttress. Mature specimens measure 42 mm. in length and 26 mm. in altitude; very large specimens attain a length of 52 mm. and an altitude of 35 mm.

Type locality: Isla de Muerte, Guayaquil.

Pliocene: Lower middle Etchegoin, lower middle Pliocene of the Coalinga region (Nomland).

Pleistocene: Rare in the lower San Pedro series of Deadman Island, Los Cerritos and Crawfish George's, Los Angeles County (Arnold); foot of 26th Street and at Spanish Bight, San Diego (Arnold; Mrs. K., Stephens' MS.); upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan).

Recent: Point Conception, California, to Guayaquil.

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[1] *Cochlodesma* J. P. Couthouy, Boston Journ. Nat. History, Vol. 2, no. 2, p. 170, 1839. Couthouy placed "*Anatina Leána* Conrad" in this new genus, including "*Mya prætenuis* Pennant" as a synonym of his type. Gray, 1847, fixed the type on Pennant's species. *Cochlodesma* has a smooth shell, the only sculpture being minute growth striæ. "*Cochlodesma*" *bainbridgensis* Clark (Univ. Calif. Publ. Geol., Vol. 15, p. 86, pl. 13, figs. 3, 4, 1924) has strong concentric undulations suggestive of *Cyathodonta*.

This is the common *Periploma* of southern California. It is more elongate and heavier shelled than *P. discus* Stearns, and lacks the concentric sculpture of *P. sulcata* Dall. *P. discus* is truly disk shaped except that the posterior end of the valves is slightly produced into a short, broad, blunt rostrum. The known living range of *P. discus* Stearns is from San Pedro to San Diego.

Section HALISTREPTA Dall, 1904

Halistrepta Dall, Natuilus, Vol. 17, p. 123, March, 1904.

Type (by monotypy), *Periploma sulcata* Dall.

Shell with undulated sculpture.

Periploma sulcata Dall

Periploma sulcata Dall, Nautilus, Vol. 17, pp. 122, 123, March, 1904; Bull. 112, U. S. Nat. Mus., p. 25, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 83, pl. 40, fig. 6, 1924; E. K. Jordan, Proc. Calif. Acad. Sci. Ser. 4, Vol. 15, p. 244, 1926.

Periploma (*Halistrepta*) *sulcata* Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, p. 427, pl. 15, fig. 10, 1908.

Type specimen: In the U. S. National Museum.

Type locality: San Pedro, California; Recent.

Pleistocene: Upper Quaternary at San Quintin Bay, Lower California, Mexico (E. K. Jordan).
Recent: San Pedro, California (Dall).

This rare species is recognized by its strong, concentric undulations.

Periploma clarki Nomland,[1] of the Santa Margarita upper Miocene near Coalinga, is based upon such a poor specimen that it is impossible to be sure from the figure that it is not a *Macoma*.

Family THRACIIDAE

Shell earthy and cellulo-crystalline, not pearly; inequivalve, thin, edentulous, often with a granular surface; the ligament and resilium chiefly external, posterior to the beaks, seated on posteriorly directed nymphæ; cardinal area none; beaks entire or perforated by friction on each other; valves nearly closed; pallial sinus present. (After Dall.)

Geologic range: Jurassic to Recent.

This family is closely related to the *Periplomatidæ* and the *Laternulidæ*, and it would probably be a convenience to all conchologists to consider them as one family.

Genus THRACIA Blainville, 1824

Rupicola Fleuriau, Journ. de Physique, Vol. 54, p. 345, 1802; not *Rupicola* Brisson, 1760, *Aves*.

Thracia (Leach MS.) Blainville, Dict. Sci. Nat., Vol. 32, p. 347, 1824; Man. Malac., Vol. 1, p. 564, 1825, Vol. 2, p. 660, 1827; Gray, Proc. Zool. Soc. London for 1847, p. 191, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1522, 1523, 1903.

Homeodesma Fischer, Man. Conchyl., p. 1171, 1887.

Type (*fide* Gray, 1847), *Thracia corbuloidea* Blainville, *op. cit.*, p. 347, 1824; figured in Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 10, *Thracia*, p. 4, pl. 1, figs. 1*a-d*, and pl. 2, fig. 1, 1834, and by Reeve (as *Thracia corbuloides* Deshayes), Conch. Icon., Vol. 12, *Thracia*, pl. 1, fig. 1, 1859; Mediterranean.

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[1] Univ. Calif. Publ. Geol., Vol. 10, pp. 307, 308, pl. 19, fig. 6, 1917.

Shell rather thin, often bluntly rostrate; sculpture lacking or consisting of concentric striæ, with or without concentric or oblique undulations, sometimes with fine granulations; beaks generally in contact, and one or both perforated (usually the right) by contact with each other. Size up to 100 mm. in length, or more.

Geologic range: Triassic to Recent.

Subgenus **THRACIA,** s. s.

Surface of valves smooth or with growth striæ only.

The typical subgenus differs from *Cyathodonta* in the lack of the obliquely concentric undulations so pronounced on *Cyathodonta undulata* Conrad, the type of *Cyathodonta*. *Thracia trapezoides* Conrad is very similar to *T. corbuloidea* Blainville, but the latter species is deeper (that is, higher from ventral margin to dorsal margin) and the rostration is more accentuated. Both species have imperfect right umbones, due to contact with the left beak. This imperfection of the right beak is typical of *Thracia, s. s.*, but *Cyathodonta* has an entire right beak or but a small eroded hole on most specimens. The ligament of *Cyathodonta* is internal on a definite chondrophore, while the ligament of *Thracia corbuloidea* and *T. trapezoides* is external. However, *Thracia pubescens* Pennant, a Mediterranean species, has an internal ligament resting on a perfectly definite chondrophore. It is much more elongate than *corbuloidea*. *Thracia magnifica* Jonas, of the Atlantic coast of Honduras, is a *Cyathodonta*, not very different from *undulata* Conrad except that it has a heavier shell and may average larger in size.

Thracia (Thracia) trapezoides Conrad

Plate 13, Figure 8

Thracia trapezoides Conrad, U. S. Expl. Exped., Geol., Vol. 10, p. 723, pl. 17, fig. 6*a*, 1849; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 90, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 267, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 122, 1903; I. S. Oldroyd, Nautilus, Vol. 32, p. 105, January, 1919; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta. pp. 1, 2, 27, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 84, pl. 43, fig. 8, 1924.

Thracia trapezoidea Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 135, pl. 2, fig. 14, pl. 13, fig. 7, 1909; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, pp. 581, 583, 584, 588, 590, 593, 596, 1913; Weaver, Washington Geol. Surv., Bull. 15, p. 18, 1912; Univ. Wash. Publ. Geol., Vol. 1, no. 1, pp. 28, 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 239, 243, 254, 1916; Howe, Vol. 14, table opp. p. 92, 1922; Waterfall, Vol. 18, pp. 78, 79, 1929.

Type specimens: U. S. National Museum, No. 3,604.

Type locality: Astoria, Oregon; Miocene.

Oligocene: "San Lorenzo horizon of the Astor series (middle Oligocene)," below Porter, Washington; also "Seattle horizon of the Astoria series" south side of entrance to Blakeley Harbor, and at Restoration Point, Bainbridge Island, Washington; also "Twin River horizon of the Astoria series" in the sea cliffs west of Twin, Olympic Peninsula, Washington (Arnold and Hannibal); Oligocene of Snohomish County, of Kitsap County, and of Wah Kia Kum County, western Washington (Weaver).

Miocene: Lower Miocene of Chehalis County, Washington (Weaver); Astoria Miocene (Dall); Empire formation of Oregon (Dall; Arnold and Hannibal; Howe); Montesano formation (Weaver).

Pliocene: Eagle Prairie, Humboldt County (Cooper); Merced and Purisima formations of middle California (Arnold and Hannibal; Martin; etc.); upper Wildcat formation of northern California (Martin); Coos conglomerate of Coos Bay region, Oregon (Howe); Pico formation near Ventura (Waterfall).

Pleistocene: "Pliocene" of Deadman Island, Los Angeles County (Arnold); ? "Pliocene," southeastern part of San Pedro (Arnold).

Recent: Puget Sound (I. S. Oldroyd, 1924); Craig, Prince of Wales Island, Alaska (G. Willett, coll.).

This species is recognized by its rather short, broad rostration. The posterior rostrated part of the valve is set off by a broad radial sulcation posterior to which is a low ridge radiating from the umbonal area to the posterior margin of the rostrum. The posterior dorsal area is laterally constricted. The average length is about 50 mm., height 40 mm.

Thracia condoni Dall, described from Smith's quarry, near Eugene, Oregon, has been shown by Clark to be an Oligocene species. It has a wider rostration and appears to attain a larger average size. Martin[1] reported a *Thracia* from the Etchegoin (Pliocene) of the Sargent oil field, which he referred to as similar to *T. condoni* Dall; but it is probably not Dall's species.

Thracia (Thracia) jacalitosana Arnold

Thracia jacalitosana Arnold, U. S. Geol. Surv., Bull. 396, p. 68, pl. 16, fig. 4, Jan. 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 38, fig. 4, 1910.

Type specimen: U. S. National Museum, No. 165,579.

Type locality: On the Stone Canyon and Coalinga road, 200 yards north of Jacalitos Creek crossing, 14 miles southwest of Coalinga (Arnold).

Pliocene: "Jacalitos formation," lower part of the Etchegoin formation, lower Pliocene, at the type locality.

According to Arnold's description and figure, this is a very deep species, the anterior-posterior measurement (51 mm.) being unusually short in relation to the dorsal-ventral depth (44 mm.). The rostration is likewise short and deep.

Thracia quentinensis Dall

Thracia quentinensis Dall, West American Scientist, San Diego, Vol. 19, No. 3, p. 21, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 28, pl. 11, fig. 1, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the U. S. National Museum.

Type locality: San Quintin Bay, Lower California, Mexico; Pleistocene.

"Shell more or less irregular, white, thin, strongly inflated, inequilateral, the beaks at about the anterior third; ends rounded, the posterior slightly compressed on the superior slope; surface minutely granulose, concentrically irregularly ridged or subundulate; base prominently arcuate; hinge feeble, pallial sinus short, rounded, free of the pallial line. Measurements of left valve: length, 47; height, 35; diameter, 12 mm." (Dall, 1921.)

Dall described this species from a unique broken specimen. Jordan placed the age of the deposit as upper Quaternary.

Thracia curta Conrad

Thracia curta Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 248, pl. 19, fig. 8, 1837; Newcombe, Bull. Nat. Hist. Soc. Brit. Columbia, p. 44, 1893; Dall, Journ. Wash. Acad. Sci., Vol. 9, no. 1, p. 2, 1919; Bull. 112, U. S. Nat. Mus., p. 25, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 84, pl. 43, fig. 6, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 153, 1924.

Type locality: Near Santa Barbara, California; Recent.

Pliocene: Late Pliocene of St. George Island, one of the Pribilof group (Dall, 1919).
Recent: Icy Cape, Arctic Ocean, Bering Sea, south to San Diego, California (Oldroyd); San Hipolito Point, Lower California, Mexico (in Hemphill Collection, Jordan).

This is a small suboval shell lacking the prominence of rostration in *trapezoides*. Jordan gave its range as from San Hipolito Point, Lower California (based upon specimens in the Hemphill Collection at Stanford University), to Ecuador, but the southern limit may be an error.

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[1] Univ. Calif. Publ. Geol., Vol. 9, p. 254, 1916.

In Volume 8 of the Proceedings of the Philadelphia Academy (p. 313, 1856) Conrad described a *Thracia mactropsis* from the Tertiary of Monterey County. This was later figured in Volume 6 of the Pacific Railroad Reports (Geological Report, Chapter 2, pl. 2, fig. 3, 1857), but it does not seem to have been recognized by later writers.

Subgenus **CYATHODONTA** Conrad, 1849

Cyathodonta Conrad, Proc. Acad. Nat. Sci. Phila., for 1849, Vol. 4, pp. 155, 156, 1849.

Type (by monotypy), *Cyathodonta undulata* Conrad.

Shell much like that of *Thracia, s. s.,* but with prominent, obliquely concentric undulations.

Thracia (Cyathodonta) undulata (Conrad)

Plate 13, Figures 6*a*, 6*b*

Cyathodonta undulata Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 4, p. 156, 1849; Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 444, 1915; Nautilus, Vol. 32, p. 24, 1918; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 466, 1926; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 141, 1927.

Cyathodonta granulosa Gould, Boston Journ. Nat. Hist., Vol. 6, p. 407, 1852, name only.

? *Cyathodonta dubiosa* Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 445, 1915, no figure; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 86, pl. 9, fig. 5, 1924.

? *Cyathodonta pedroana* Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 445, 1915, no figure; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 86, pl. 54, figs. 1, 2, 3, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925.

"Subovate, inequilateral, very thin and fragile, with obliquely concentric undulations, profound on the anterior side, and suddenly becoming obsolete towards the posterior extremity, which is truncated and direct; posterior slope of the deeper valve obscurely tricarinated; cartilage pit robust; valves with minute, very closely arranged, granulated radiating lines, $1^2/_{10}$:1 nearly." (Conrad.)

Pliocene: Coyote Mountain, western Imperial County (Hanna); Santa Antonita Point, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (as *C. pedroana* Dall, T. S. Oldroyd); upper Pleistocene at Magdalena Bay, Lower California, Mexico (Dall).

Recent: Catalina Island (as *C. pedroana* Dall) and San Pedro to west Mexican coast.

This species was described by Conrad, without figure, along with several other forms stated to have come from "the coasts of Lower California and Peru." The shells we have seen from San Pedro and San Diego labeled *C. undulata* seem to fit Conrad's description of that species. These specimens indicate that considerable variation in the shape of the valves and in the character of the concentric ripples is the rule in this group and we do not believe that the distinctions Dall has used for the separation of *dubiosa* and *pedroana* as full species are significant.

Thracia (*Cyathodonta*) *plicata* Deshayes (Encycl. Méth. Vers, Vol. 3, p. 1039, 1832) as figured in Kiener's Iconographie (Vol. 11, *Thracia,* pl. 2, fig. 3) is more elongate than the San Diego shells assigned to *undulata*.

Thracia (Cyathodonta) formosa Nomland

Thracio formoso Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 234, pl. 9, figs. 4, 4*a*, April 19, 1917.

Type specimen: University of California collection, No. 11,103.

Type locality: On Zapato Creek, Fresno County; middle Pliocene.

Pliocene: "*Pecten coalingensis* zone," middle Etchegoin, middle Pliocene, on Zapato Creek, Fresno County (Nomland).

From Nomland's figure this species seems to be similar to *T.* (*Cyathodonta*) *undulata* Conrad. The concentric ripples are perhaps finer and closer together than on Conrad's species. The "tooth" mentioned by Nomland must be the cartilage pit if the shell is a *Thracia*, but we have not seen the type.

Superfamily PANDORACEA (=ADELOSIPHONIA Dall)

Family PANDORIDAE

Shell compressed, rather flat, inequivalved, free, nacreous with a thin external prismatic layer; dorsal edges of the valves overlapping, not socketed, with crural ridges or teeth on either side of the resilium; ligament external or obsolete; resilium internal, posterior to the beaks, with or without a lithodesma; cardinal area, none; valves closed, beaks not perforated by contact with each other; pallial line simple.

Genus **PANDORA** Hwass in Chemnitz, 1795

Pandora Hwass, Chemnitz, Neues Syst. Conchyl. Cab., Vol. 11, p. 211, 1795, *Tellina inæquivalvis* included; Bruguière, Encycl. Méth., Vers, liv. 2, p. 250, 1797; Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 88, 1799; Schumacher, Ess. Nouv. Syst. Hab. Vers Test., p. 114, 1817; Children, Quart. Jour. Sci., Lit., Arts, p. 302, January, 1823; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1515, 1516, 1903.

Type (by subsequent designation, Children, 1823), *Tellina inæquivalvis* Linnæus (*Solen inæquivalvis* Linnæus, 1758; *Pandora rostrata* Lamarck).

Shell closed, rather flat, inequivalved, the right valve flat or but little convex and frequently overlapped on its ventral margin by the left valve; posterior portion of valves somewhat attenuated; hinge with diverging cardinal, crural ridges or teeth; shell substance pearly with prismatic layer outside. Size small, up to about 50 mm. in length.

Geologic range: Cretaceous to Recent.

Distribution: Widely distributed in cold and temperate waters.

Volume 11 of Chemnitz is accepted as binomial by many writers who do not accept the rest of Chemnitz. The whole work is entitled to consideration as a binary work in the technical sense of the International Commission on Zoological Nomenclature, though it is not binomial. Dating *Pandora* from Bruguière, 1797, would not change its application, for its type (by monotypy) would be *Pandora margaritacea* Lamarck, a variety of *inæquivalvis* (*fide* Stewart).[1]

Section PANDORA, s. s.

Right valve with two cardinals; left valve with one obscure cardinal or none; lithodesma absent; right valve with feeble concentric sculpture.

The typical section is not represented in the Neocene or Quaternary of California.

Section KENNERLIA Carpenter, 1864

Kennerlia Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 602, 638, 1864; Proc. Zool. Soc. London, p. 602, 1864; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1517, 1903.

Type (by subsequent designation, Dall, 1903), *K. filosa* Carpenter.

Like *Pandora, s. s.*, but with a lithodesma; right valve with fine but widely spaced and somewhat irregular radial striæ.

The radial striations on these shells are wide apart, sometimes discontinuous, and much resemble cracks in chinaware. For the section name we have returned to the original spelling of Carpenter.

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[1] Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 303, 1930.

Pandora filosa (Carpenter)

Kennerlia filosa Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 602, 638, 1864; Proc. Zool. Soc. London, pp. 602, 603, 1864.

Pandora filosa Carpenter, Sowerby, Reeve's Conchologia Iconica, Vol. 19, *Pandora*, pl. 2, figs. 10*a-b*, 1874.

Pandora (*Kennerlia*) *filosa* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 124, pl. 18, fig. 3, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 26, 1921.

Kennerlyia filosa Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 449, 1915.

Pandora (*Kennerlyia*) *filosa* Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 88, pl. 33, figs. 2*a*, 2*b*, 1924.

Type locality: Puget Sound; Recent.

Pleistocene: Lower San Pedro series of Deadman Island, one right and one left valve (Arnold).
Recent: Nunivak Island, Bering Sea, to San Pedro, California.

This is a small elongate species, measuring about 22 mm. in length and 10 mm. in height. The posterior end is definitely attenuated into a rostrum. The posterior dorsal margin is approximately straight, below which, on the right valve only, there are generally one or two radial sulcations nearly parallel but diverging slightly from the margin. The anterior dorsal margin is straight or but slightly convex and about one third the length of the posterior margin. The left valve is ventricose, irregularly undulating; the right valve being flat and radially sculptured on its exterior prismatic layer.

Pandora bilirata Conrad

Pandora bilirata Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 7, p. 267, 1855; U. S. Pacific R. R. Repts., Vol. 6, Geological Report, p. 73, pl. 5, fig. 25, 1857.

Kennerlia bicarinata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 638, 1864; Proc. Zool. Soc. London, 1864, p. 603; Tryon, Struct. Syst. Conch., Vol. 3, p. 143, 1884.

Pandora (*Kennerlia*) *bicarinata* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 123, pl. 18, fig. 2, 1903.

Pandora (*Kennerlyia*) *bilirata* Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 449, 1915; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 89, pl. 53, figs. 8, 9, 1924.

Pandora (*Kennerlia*) *bilirata* Conrad, Dall, U. S. Nat. Mus., Bull. 112, p. 26, 1921.

Oblong, very inequilateral, contracted anteriorly, convex medially; posterior side with two distinct, carinated lines toward the hinge margin which is straight and not oblique; posterior extremity truncated. Length, 15 mm.; height, 6 mm. (Conrad.)

Pleistocene (or *Pliocene ?*): Of Santa Barbara (Conrad, 1857).
Pleistocene: Lower San Pedro series of Deadman Island, one left valve (Arnold).
Recent: Forrester Island, Alaska, to Point Abreojos, Lower California.

This species differs from *P. filosa* by the rounded posterior margin, which in *filosa* is rostrated. The beaks are also nearer the middle in *bilirata*.

Pandora grandis Dall

Plate 13, Figures 5*a*, 5*b*

Pandora (*Kennerlia*) *grandis* Dall, "Proc. Calif. Acad. Sci., Vol. 7, p. 5, 1877," unauthorized separate[1]; Dall, Bull. 112, U. S. Nat. Mus., p. 25, 1921.

Kennerlyia grandis Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 448, 1915.

Pandora grandis Dall, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

Pandora (*Kennerlyia*) *grandis* Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 448, 1915; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, pp. 87, 88, pl. 15, fig. 10, 1924.

Type specimen: U. S. National Museum, Cat. No. 171,069.

Type locality: Unalaska.

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[1] This separate was never included by the California Academy in their Volume 7. In their hurry to describe new species both Stearns and Dall resorted to the private publication of leaflets, without illustrations, which were stated to be from the Proceedings of the California Academy of Sciences but which never were. These fragile, easily destroyed, and now rare leaflets are an annoyance to those who attempt to work from original sources.

Miocene: St. Paul Island, Alaska (Dall, 1896).
Pliocene: Lower part of the Merced formation, Seven Mile beach just south of San Francisco, San Mateo County, and upper division of the Wildcat series, Humboldt County (Martin, 1916).
Pleistocene: Santa Monica, Los Angeles County (Dall, 1915).
Recent: Pribilof Islands, Bering Sea, to Siletz Bay, Oregon (Dall, 1921).

This species is easily recognizable by its large size, curved dorsal margin and lack of rostration. Length, 55 mm.; height, 38 mm.

Pandora glacialis Leach

Pandora glacialis W. E. Leach, in J. Ross, Voy. Discov. Baffin's Bay, Ed. 2, 8vo, Appen. 4, p. 174, July, 1819; Sowerby, Reeve's Conch. Icon., Vol. 19, *Pandora*, sp. 14, pl. 2, figs. 14*a*-*b*, 1874.
Pandora (*Kennerlyia*) *glacialis* Leach, Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 448, 1915; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 89, pl. 42, figs. 3, 4 (pl. 15, fig. 11 ?), 1924.
Pandora (*Kennerlia*) *glacialis* Leach, Dall, Bull. 112, U. S. Nat. Mus., p. 26, 1921; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: Greenland seas; Recent.

Pliocene: Pico formation (upper Pliocene part), near Ventura (Waterfall).
Recent: Arctic Ocean and south to Fuca Straits; also Atlantic (Dall, 1921).

This species is well figured in Reeve's "Conchologia Iconica." According to these figures, the right valve has two or three posterior radial plications and a broad sulcation ventral to them. The only fossil record in California is that of Waterfall.

Section HETEROCLIDUS Dall, 1903

Heteroclidus Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1518, October, 1903.

Type (by original designation), *Clidiophora punctata* Conrad, = *Pandora punctata* Conrad.

Left valve with the posterior cardinal crural ridge or tooth absent; right valve with a short posterior cardinal and a produced anterior cardinal ridge; both the anterior ridges, or teeth, ending in front of the anterior adductor scar; lithodesma present.

Pandora punctata Conrad

Plate 13, Figures 2*a*, 2*b*

Pandora punctata Conrad, Jour. Acad. Nat. Sci., Phila., Vol. 7, p. 228, pl. 17, fig. 1, 1837; Sowerby, Reeve's Conch. Icon., Vol. 19, *Pandora*, sp. 13, pl. 2, fig. 13, 1874; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 219, 1917; Jordan, Proc. Calif. Acad. Sci., Ser. 4, p. 244, 1926.
Clidophora punctata Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 90, 1868-9.
Clidiophora punctata Conrad, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 235, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 183, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 124, 1903; Arnold, U. S. Geol. Surv., Bull. 396, p. 160, pl. 27, fig. 10, January, 1910; Arnold and Anderson, Bull. 398, p. 335, pl. 49, fig. 10, 1910; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.
Pandora (*Heteroclidus*) *punctata* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1521, 1903; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 90, pl. 53, figs. 6, 7, 1924.
Pandora (*Heteroclidus*) *punctatus* Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 450, 1915; Bull. 112, U. S. Nat. Mus., p. 26, 1921; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.
Pandora (*Clidiaphora*) *punctata* Conrad, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

? Miocene: Ventura County (Gabb, 1868-9; Cooper, 1888 = ? var. *gabbi* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1521, 1903, possibly not Miocene).
Pliocene: Etchegoin formation of Coalinga region (Arnold and R. Anderson, 1910; Nomland, 1917); upper Sargent or Merced formation of the Sargent oil field, near Sargent, San Benito County (? Cooper; Nomland; Martin); Purisima formation along the coast south of Halfmoon Bay, middle California (Martin).

Pleistocene: Lower San Pedro series of Deadman Island, rare; Spanish Bight, North Island, San Diego; upper San Pedro series of San Pedro (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan); numerous localities in the "Saugus" or Las Posas zone near and east of Ventura (Waterfall; also collected by the present authors).
Recent: Vancouver Island to the Gulf of California (Dall, 1921).

This species is readily recognized by its strongly curved (concave) posterior dorsal margin and the small punctations on the inner surface of the valves. The anterior dorsal margin is short and evenly curved to the ventral margin. Fossil specimens are frequently about 40 mm. in length.

The "Miocene" occurrence of this species is based on the records of Gabb and Cooper. It is probable that their Miocene is now regarded as Pliocene, but lack of exact locality data makes it impossible to determine definitely. The form without punctations from this "Miocene," which Dall has named variety *gabbi*, has not been recognized by us in the collections available.

Family LYONSIIDAE

Shell inequivalve, thin, sub-nacreous, edentulous; ligament obsolete, the resilium internal, uniting the edges of a long, mesial lithodesma to a narrow chondrophoric sub-marginal ridge on each valve; beaks entire, valves nearly closed, pallial sinus distinct. (Dall.)

Genus LYONSIA Turton, 1822

Lyonsia W. Turton, Conchylia Insularum Britannicarum, pp. xvii and 34, 1822; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 635, 1846; Gray, Proc. Zool. Soc. London, Pt. 15, p. 191, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1513, 1514, 1903.

Type (by monotypy), *Mya striata* Montagu, 1822 = *Mya norwegica* Gmelin, 1790 = *Mya norvegica* Chemnitz, Neues Syst. Conch. Cab., Vol. 10, p. 345, pl. 170, figs. 1647 and 1648, 1788; also figured by Forbes and Hanley, Hist. Brit. Moll., Vol. 1, p. 214, 1853, Vol. 4, pl. 8, figs. 6-9; west coast of Ireland, Recent.[1]

Shell rather small, thin, internally nacreous; valves unequal, elongate, posterior distally truncated; sculpture consisting of radial striations.

Geologic range: Tertiary to Recent.

Distribution: Coasts of Europe, Greenland, North America, etc.

This genus has a number of synonyms, some of which are referred to by Gray, Dall, and others.

Lyonsia californica Conrad

Lyonsia californica Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 248, pl. 19, fig. 20, 1837; Keep, West Coast Shells, p. 202, fig. 174, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 125, 1903; Keep, West American Shells, p. 99, fig. 88, 1904; Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 453, 1915; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 252, 1916; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 261, pl. 18, fig. 3, 1918; Dall, Bull. 112, U. S. Nat. Mus., p. 26, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 91, pl. 27, fig. 3, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: U. S. National Museum, No. 253,111.

Type locality: Near Santa Barbara, California; Recent.

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[1] Dall (Proc. U. S. Nat. Mus., Vol. 49, p. 452, 1915) separates *L. striata* (Montagu) specifically from *L. norvegica* (Gmelin). These forms are so close, however, that the conception of the genus is not influenced whether the one or the other is taken as type.

Pliocene: Middle part of the Wildcat formation, Humboldt County (Martin).
Pleistocene: "Pliocene" of Deadman Island, also lower San Pedro series of Deadman Island and San Pedro (Arnold, 1903); lower San Pedro fauna of Nob Hill cut in San Pedro (T. S. Oldroyd); Pleistocene of San Diego (in Oldroyd Collection); upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Puget Sound to Manuel's Lagoon, Lower California, Mexico.

This is an elongate-ovate shell with the posterior portion slightly attenuated. It has delicate radial sculpture.

Lyonsia arenosa (Möller)

Pandorina arenosa H. P. C. Möller, Index Molluscorum Groenlandiæ, p. 20, 1842; Gray, Zool. Beechey's Voy. to the Pacific, etc., pl. 43, fig. 3, 1839.
Lyonsia flabellata Gould, Otia Conch., p. 162, 1861.
Lyansia arenosa Möller, Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896; Trans. Wagner Inst. Sci., Vol. 3, p. 1514, 1900; Proc. U. S. Nat. Mus., Vol. 49, p. 453, 1915; U. S. Nat. Mus., Bull. 112, p. 26, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 92, 1924.

Miocene: Miocene of St. Paul Island, Alaska (Dall, 1896).
Pleistocene: Leda clays of the Pleistocene in Maine, New Brunswick and Quebec (Dall, 1900).
Recent: Arctic Sea to Japan and the Okhotsk Sea on the west, and on the east to the Aleutians and Kodiak Island, Alaska; also North Atlantic.

According to Dall, this is a short and solid species well distinguished from any others.

Genus MYTILIMERIA Conrad, 1837

Mytilimeria Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, pp. 246, 247, pl. 19, fig. 5, 1837, *M. nuttallii* only species; Tryon, Struct. Syst. Conch., Vol. 3, p. 147, 1884.

Type (by monotypy), *Mytilimeria nuttallii* Conrad, California, Recent and fossil.

Shell rounded-oval, more or less ventricose, equivalve, fragile, covered by a thin caducous epidermis; beaks subspiral; hinge without teeth, but formed of small linear excavations under the beaks to receive the ligament, which contains a small ossicle; muscular impressions small, pallial impression with an obtuse sinus. (Tryon.)

Mytilimeria nuttallii Conrad

Mytilimeria nuttallii Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 247, pl. 19, fig. 5, 1837; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 540, 601, 638, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 90, 1868-9; Tryon, Struct. Syst. Conch., Vol. 3, p. 147, pl. 108, fig. 68, 1884; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 252, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 126, pl. 17, fig. 8, 1903; Keep, West American Shells, p. 100, 1904; Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 456, 1915; Bull. 112, U. S. Nat. Mus., p. 27, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 94, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925.

Type specimen: U. S. National Museum, No. 74,234.

Type locality: California; Recent.

Shell suboval, inflated, thin, fragile; white, with a very thin, yellowish, deciduous epidermis. (Conrad.)

? Miocene: Tomales (Gabb).
Pleistocene: "Pliocene" of Deadman Island, rare; lower San Pedro series of Deadman Island, rare, and of San Pedro (Arnold); lower San Pedro series of Nob Hill cut, San Pedro (Oldroyd, 1925).
Recent: Vancouver Island to Round Island, Lower California, Mexico (Jordan).

There does not seem to be any later confirmation of Gabb's Miocene record of this species.

Superfamily POROMYACEA

Family CUSPIDARIIDAE

Shell sub-equivalve, rostrate, earthy or cellulo-crystalline, rarely with surface granulations; hinge edentulous or with sub-umbonal tuberculation, sometimes buttressed; ligament sub-internal, anterior to the beaks or obsolete; resilium internal, with a mesial or ventral lithodesma; cardinal area amphidetic or obscure; valves closed except at the tip of the rostrum; pallial line simple; siphons united. (Dall.)

Genus **CUSPIDARIA** Nardo, 1840

Neæra Gray, in Griffith's Cuvier, legend to pl. 21, fig. 5, 1834; not *Neæra* Robineau-Desvoidy, 1830.

Cuspidaria G. D. Nardo, Atti. Riun. Sci. Ital., Vol. 1, p. 175, 1839 (1840); Ann. Sci. Lomb. Ven., Vol. 10, p. 50, 1840; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 12, no. 6, pp. 292-294, 1886; Proc. U. S. Nat. Mus., Vol. 12, p. 279, 1889; Trans. Wagner Inst. Sci., Vol. 3, pp. 1503, 1504, 1903.

Type (*fide* Dall, 1886), *Tellina cuspidata* Olivi, Zool. Adriatica, p. 101, 1792; Adriatic; Recent; also reported from the Miocene of Baden, near Vienna.

Shell concentrically sculptured; hinge with a small posteriorly inclined chondrophore in each valve, and an elongate ridge behind it; ligament when present always anterior to the beaks. (Dall.)

Geologic range: Jurassic to Recent.

Distribution: All seas; abundant in deep water.

Subgenus **CUSPIDARIA**, s. s.

Valves smooth or concentrically feebly sculptured, fossette posteriorly inclined and attached to the hinge margin by its posterior edge; one posterior lateral tooth in the right valve. (Dall, 1903.)

Subgenus **CARDIOMYA** A. Adams, 1864

Cardiomya A. Adams, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 330, 1864.

Type (by monotypy), *Neæra gouldiana* Hinds; Japanese seas; Recent.

Like *Cuspidaria, s. s.*, but with radial sculpture and more vertical and prominent fossette.

Cuspidaria (Cardiomya) pectinata (Carpenter)

Plate 1, Figures 16, 17

Neæra pectinata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 602, 637, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 54; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 181, pl. 18, fig. 11, 1903.

Cuspidaria pectinata Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 28, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 101, 1924.

Type locality: Puget Sound.

Pleistocene: Lower San Pedro series at Deadman Island, Los Angeles County, "one valve" (Arnold).
Recent: Puget Sound, British Columbia to Panama Bay (Oldroyd).

This little shell is obtained by dredging along the southern California coast. Mrs. I. S. Oldroyd has dredged many specimens in ten or twelve fathoms in Puget Sound. The species is rare as a fossil.

The subgenus *Cardiomya* is well represented in the Eocene of California.

Family VERTICORDIIDAE

Shell equivalve or nearly so, variable in shape, valves closed; hinge with a strong tooth in the right valve anterior to the resilium, and dorsal margins modified to overlap each other; ligament obsolete, resilium posterior to the beaks, with a lithodesma; pallial line entire or with a shallow sinus. (After Dall.)

Genus VERTICORDIA S. Wood in Sowerby, 1844

Verticordia J. E. Gray, Synopsis of the Contents of the British Museum, Ed. 42, p. 150, 1840, nude name, Ed. 44, p. 80, practically a nude name; *fide* Iredale, Proc. Malac. Soc. London, Vol. 10, pp. 299, 309, 1913.

Verticordia S. Wood in Sowerby, Min. Conch. Gt. Brit., Vol. 7, p. 67, pl. 1139, 1844; Dall, Trans. Wagner Free Inst. Sci., Vol. 3, p. 1509, 1903.

Type (by monotypy), *Verticordia cardiiformis* J. Sowerby; England, Pliocene.

Shell small, nacreous, beaks strongly prosogyrous; sculpture consisting of radial ribs.

Verticordia ornata (d'Orbigny)

Plate 13, Figure 4

Trigonulina ornata d'Orbigny, in R. de la Sagra, Hist. Phys. Polit. et Nat. Cuba, Moll., Vol. 2, p. 292, pl. 27, figs. 30-33, 1846.

Hippagus novemcostatus Adams and Reeve, Zool. Voy. Samarang, Mollusca, p. 76, pl. 24, fig. 1, Aug., 1850, "Hab. China Sea."

Verticordia (*Trigonulina*) *ornata* d'Orbigny, Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 12, no. 6, p. 290, 1886.

Verticordia ornata Orbigny, Dall, Bull. 112, U. S. Nat. Mus., p. 29, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 103, pl. 54, figs. 15-18, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925.

Pleistocene: Lower San Pedro fauna of Deadman Island, "one specimen" (Arnold); lower San Pedro of Nob Hill cut, San Pedro (T. S. Oldroyd).

Recent: Catalina Bay, California, to Panama; also Japan and the Antilles (Dall, 1921).

This small shell has eight or nine very prominent radial ribs on the anterior two-thirds of the valves. The length averages about 4 mm. and the height about 3.5 mm. Dall considered the southern California specimens conspecific with d'Orbigny's species from the West Indies. The figure of *Hippagus novemcostatus* Adams and Reeve in the Voyage of the Samarang shows no significant difference from southern California specimens of *ornata*.

ORDER TELEODESMACEA

Superfamily ASTARTACEA

Family ASTARTIDAE

Shell substance cellulo-crystalline, with a pronounced epidermis; shell rounded or subtriangular, usually with concentric but not radial sculpture; valves equal or subequal, free, closed; area distinct; ligament and resilium external, behind the beaks; adductor scars subequal, with a distinct anterior pedal scar; pallial line simple; hinge plate distinct, the anterior and posterior laminæ and their respective sockets usually more or less obsolete; cardinal teeth not bifid at the summit, usually three in the left valve and two in the right, but the terminal teeth sometimes obsolete. (After Dall.)

Geologic range: Triassic to Recent.

Genus ASTARTE Sowerby, 1816

Astarte Sowerby, Mineral Conchology of Great Britain, Vol. 2, p. 85, 1816, species included, *A. lurida* Sowerby, *A. elegans* Sowerby, and *A. cuneata* Sowerby; Stoliczka, Mem. Geol. Surv. India, Palæontologia Indica, Vol. 3, p. 278, 1871; E. A. Smith, Jour. Conch., Vol. 3, pp. 196-232, 1881; Dall, Proc. U. S. Nat. Mus., Vol. 26, pp. 933-937, 1903; Trans. Wagner Inst. Sci., Vol. 3, pt. 6, pp. 1485-1488, 1903.

Tridonta Schumacher, Ess. Nouv. Hab. Vers Test., p. 146, 1817, sole example, "*Venus borealis* Linnæus," Chemnitz.

Crassina Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 554, 1818.

Rictocyma Dall, Amer. Jour. Conch., Vol. 7, no. 2, p. 151, Nov. 2, 1871, sole species, *A. mirabilis* Dall.

Type (by subsequent designation, Stoliczka, 1871), *Astarte lurida* Sowerby, "Foxhill Quarries, Gloucester," England; Jurassic, figured by Sowerby, *op. cit.*, pl. 137, fig. 1.

Geologic range: Jurassic to Recent (Triassic ?).

Distribution: Arctic, Antarctic, and cold temperate waters.

Shell thick, ovate to subtriangular, rather flat; smooth, with growth lines, or concentrically waved, never with radial sculpture; lunule generally distinct, impressed; anterior right cardinal strong.

This genus has been subjected to considerable subdivision, most of which appears to be unnecessary and not leading to a natural grouping of related species. Many of these subdivisions are referred to by Dall in his works listed above (1903). As pointed out by Dall and others, the members of this genus are subject to variation in several characters. In general the *Astartes* are indicators of cold-water conditions.

In the following list of species no attempt has been made to include a complete synonymy. There are far too many names.

Astarte borealis (Schumacher)

Tridonta borealis Schumacher, Ess. Nouv. Syst. Hab. Vers Test., p. 47, pl. 17, fig. 1, 1817.

Astarte borealis Schumacher, E. A. Smith, Journ. Conchology, Vol. 3, pp. 216-220, 1881; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 941, 1903; Wash. Acad. Sci., Alaska, Results Harriman Alaska Exped., Vol. 4, p. 121, 1904, reissued as Smithsonian Inst., Harriman Alaska Series, Vol. 4, p. 121, 1910; Canadian Arctic Exped., Vol. 8, Pt. A, p. 26A, 1919; Harmer, Monographs Palæontographical Society, "Pliocene Moll. Great Brit.," Vol. 2, pt. 1, p. 488, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 30, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 106, 1924.

Astarte borealis Gray, Dall, U. S. Geol. Surv., 17th Ann. Rept., p. 844, 1896, erroneously as of "Gray."

Miocene: St. Paul Island, Alaska (Dall, 1896).
Pliocene: In the *Astarte borealis* zone, Icenian, upper Pliocene (Norwich horizon) of England (Harmer).
Pleistocene: Douglas Island, near Juneau, Alaska (Dall, 1904); south side of Herschel Island, Yukon Territory; also north and south side of Bernard Harbor (Dall, 1896).
Recent: Polar and Bering seas, north Japan, and eastward to Prince William Sound, Alaska.

Alaskan specimens of this species are somewhat elongate, with the concentric undulations pronounced on the upper (umbonal) quarter or half of the valves, but smooth or with growth lines only on the remainder.

A. semisulcata Leach, 1819, *A. veneriformis* Wood, 1828, *A. lactea* Broderip and Sowerby, 1829, appear to be synonymous. According to Dall, *richardsoni* Reeve, 1855, *placenta* Mörch, and *rhomboidalis* Leche, 1883, are based upon the young of Schumacher's species. *Astarte arctica* Gray is similar to *borealis* and has been united with it by E. A. Smith and others. Sars'[1] figure of "*Tridonta borealis,* Chemn." may represent *arctica* Gray. Schumacher's name may be invalidated by *Venus borealis* Linnæus, although the true Linnæan species is a *Lucina*.

Astarte arctica (Gray)

Crassina arctica Gray, Appendix Parry's Voy., p. 243, 1824.

Astarte arctica Gray, Dall, Proc. U. S. Nat. Mus., Vol. 26, pp. 940, 941, 1903; Canadian Arctic Exped., Vol. 8, Pt. A, p. 26A, 1919; U. S. Nat. Mus., Bull. 112, p. 30, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 106, 1924.

Generally larger and not so elongate as *A. borealis*.

Pleistocene: South side of Herschel Island, Yukon Territory (Dall, 1919).
Recent: Circumboreal; Arctic and Bering seas, and the Aleutian Islands.

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[1] Sars, Mollusca Regionis Arcticæ Norvegiæ, pl. 5, figs. 8*a*-*b*, 1878.

Astarte corrugata (Brown)

Crassina corrugata T. Brown, Illustr. Conch. Gt. Brit., Ed. 1, pl. 16, fig. 24, 1827, name and figure only; Ed. 2, p. 96, pl. 40, fig. 24, 1844.

Astarte corrugata Brown, Middendorff, Mal. Ross., p. 564, pl. 17, figs. 8-10; Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 359, pl. 7, figs. 2*a*-*e*, 1850.

Type locality: Scottish coast; Recent.

Grewingk reported this species from the Tertiary of St. Paul Island. There are such great similarities between Brown's and Grewingk's figures of *corrugata* and specimens in the Oldroyd Collection at Stanford University labelled *rollandi* Bernardi, 1858, that we believe they may represent one species. If the Oldroyd specimens are correctly identified, *rollandi* may become a synonym of *corrugata*.[1]

Astarte fabula Reeve

Astarte fabula Reeve, in Belcher's Last of the Arctic Voyages, Vol. 2, Appendix, p. 398, pl. 33, figs. 5*a*-*b*, 1855; E. A. Smith, Jour. Conch., Vol. 3, p. 220, 1881; Dall, Expedition to Point Barrow, p. 183, 1885; Canadian Arctic Expedition, Vol. 8, Pt. A, p. 26A, 1919; U. S. Nat. Mus., Bull. 112, p. 30, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 107, pl. 19, figs. 4, 4*a*, 1924.

Shell of medium size, not very flat, beaks very prominent, the anterior dorsal margin long and strongly concave; sculpture of fine concentric undulations.

Pleistocene: South and east sides of Herschel Island and at Kay Point, Yukon Territory (Dall, 1919).
Recent: Circumboreal; Arctic Sea and south in Bering Sea to Nunivak Island (Dall, 1921).

Astarte rollandi Bernardi

Astarte rollandi Bernardi, Jour. Conchyl., Vol. 7, p. 386, pl. 13, fig. 4, 1858; E. A. Smith, Jour. Conch., Vol. 3, p. 220, 1881; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 943, 1903; Bull. 112, U. S. Nat. Mus., p. 30, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 105, pl. 53, fig. 2, 1924.

Type locality: Petropaulovski, Kamchatka; Recent.

? Tertiary: Of Alaska ?
Recent: Pribilof and Aleutian Islands to Prince William Sound, Alaska; also Kamchatka (Dall, 1921).

If *Astarte rollandi* is distinct from *A. corrugata* (Brown) and *A. borealis* (Schumacher), it is possible that the shell which Grewingk reported as *A. corrugata* from the Tertiary of St. Paul Island, Alaska, should be assigned to Bernardi's species.

Astarte alaskensis Dall

Plate 13, Figures 3*a*, 3*b*

Astarte alaskensis Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 946, pl. 63, fig. 2, 1903; Canadian Arctic Exped., Vol. 8, Pt. A, p. 26A, 1919; Bull. 112, U. S. Nat. Mus., p. 30, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 34, pl. 3, fig. 9, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 106, pl. 13, fig. 20, 1924.

Type specimen: U. S. National Museum, No. 109,274.

Type locality: Unimak Island, southern part of Bering Sea; Recent.

Pleistocene: South and east sides of Herschel Island, Yukon Territory (Dall, 1919).
Recent: Southern Bering Sea, the Aleutians, and south to Puget Sound; Herschel Island, Arctic coast (Dall, 1921).

This handsome species has prominent concentric ripples. Mr. George Willett obtained many specimens in the open sea off Forrester Island, Alaska, and also in the straits.

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[1] Eichwald, p. 133, 1871, attributes Grewingk's *Astarte corrugata* to the Cretaceous and renames it *Astarte paulina*. See the note on *Mya arenaria* variety *profundior*, page 414.

A. willetti Dall (Nautilus, Vol. 31, p. 10, 1917) is smaller, relatively more ventricose, and has fine concentric riblets. Mr. Willett, who has done considerable collecting in Alaskan waters, obtained this latter species in the open sea off Forrester Island, but not in the straits.

In a paper published in 1920, Dall described six new species of *Astarte* from the northern Pliocene. These species are listed below.

Astarte actis Dall

Astarte actis Dall, Jour. Wash. Acad. Sci., Vol. 9, no. 1, p. 2, 1919, list name only; U. S. Geol. Surv., Prof. Paper 125-C, p. 31, pl. 6, figs. 4, 5, Jan. 27, 1920.

Pliocene: St. George Island, one of the Pribilof group (Dall).

Astarte carteriana Dall

Astarte carteriana Dall, U. S. Geol. Surv., Prof. Paper 125-C, pp. 31, 32, pl. 6, figs. 1, 3, 1920.

Pliocene: Carter Creek, Camden Bay region, Arctic coast.

Astarte diversa Dall

Astarte (Gonilia ?) diversa Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 33, pl. 5, fig. 6, 1920.

Pliocene: Half a mile northwest of Nome, Alaska, from a submarine beach thirty feet below the level of the sea (Dall).

Astarte hemicymata Dall

Astarte hemicymata Dall, U. S. Geol. Surv., Prof. Paper 125-C, pp. 32, 33, pl. 6, figs. 9, 10, 1920.

Pliocene: Same locality as preceding.

Astarte leffingwelli Dall

Astarte leffingwelli Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 32, pl. 6, figs. 6, 8, 1920.

Pliocene: In talus below low bluff on the sea coast fifteen miles southwest of Point Barrow (Dall).
? Pleistocene: About thirty miles southwest of Point Barrow at Peard Bay, "propably Pleistocene" (Dall).

The type specimens of the above forms are in the U. S. National Museum. As we have seen no specimens, the reader is referred to the original descriptions and figures.

Family CRASSATELLITIDAE

Shell similar to that of the *Astartidæ* but often rostrated; ligament obsolete or internal, resilium internal; hinge plate often heavy, lateral teeth and sockets alternate, posterior cardinal in right valve small or obsolete.

Geologic range: Lower Cretaceous to Recent.

Genus CRASSINELLA Guppy, 1874

Thetis C. B. Adams, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 9, January, 1845; not *Thetis* Sowerby, 1826.
Gouldia sp. C. B. Adams, Cat. Gen. Spec. Rec. Shells in Coll. C. B. Adams, p. 29, footnote, 1847 (includes *G. cerina* Ad. and *G. parva* Ad.); not *Gouldia* Boneparte, 1850.
Crassinella Guppy, Geological Magazine, Decade 2, Vol. 1, p. 442, Oct., 1874; Vol. 2, p. 42, 1875; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1475, 1903; Woodring, Carnegie Inst., Publ. No. 366, p. 96, 1925; not *Crassinella* Bayle, 1879.

Type (by monotypy), *Crassinella martinicensis* d'Orbigny, Recent and Pliocene of Trinidad (Guppy).

Shell small, the dorsal margin triangular, the ventral margin more or less evenly curved; valves rather flat; hinge with internal ligament and resilium, a small chondrophore and two cardinals in each valve, the two left separated by the chondrophore, the two right anterior to the chondrophore, hinge also provided with a right anterior lateral and a left posterior lateral; sculpture consisting of concentric riblets.

Geologic range: Eocene to Recent.

Distribution: Tropical and temperate Atlantic, and eastern Pacific waters.

The Crassinellas are small shells, generally about 2 mm. to 10 mm. in length. The hinge is much less massive than that of *Crassatellites*. The group appears to be more closely related to the *Astartidæ* than to the *Crassatellitidæ*.

Crassinella was first proposed by Guppy, without description, as a new genus including but one species, *C. martinicensis* d'Orbigny. A year later (1875) he explained that it was a substitute for *Gouldia* C. B. Adams, preoccupied for birds.[1] The original use was with but one species, without mention of *Gouldia;* hence, this species is the monotype. According to Dall, Guppy misidentified d'Orbigny's species;[2] but the opinions of the International Commission on Zoological Nomenclature indicate that d'Orbigny's species should be considered the type, notwithstanding.

Crassinella branneri (Arnold)

Astarte (*Crassinella*) *branneri* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 127, pl. 18, fig. 12, 1903.

Crassinella branneri Arnold, Dall, Bull. 112, U. S. Nat. Mus., p. 31, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 110, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: U. S. National Museum, No. 162,527.

Type locality: Signal Hill [Los Cerritos], Los Angeles County, California.

Pleistocene: Upper San Pedro series of San Pedro and Los Cerritos, rare (Arnold); upper Quaternary of San Quintin Bay, Lower California, Mexico (Jordan); foot of Twenty-sixth Street, San Diego (Arnold).

Recent: San Diego, California, to Panama (Dall).

Genus **CRASSATELLITES** Krueger, 1823

Crassatellites J. F. Krueger, Geschichte der Urwelt, Vol. 2, p. 466, 1823; Harris, Cat. Tertiary Moll. Brit. Museum, Pt. 1, p. 363, 1897; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1468, 1903.

Crassatella Lamarck, Syst. Anim. s. Vert., p. 119, 1801, not of Lamarck, 1799; *Crassatella* of some other authors.

Type (by subsequent designation, Harris, 1897), "*Crassatella sinuata*, Lamarck" (? of Krueger[3]), = *Crassatella gibbosula* Lamarck; Paris Basin; Eocene.

Shell solid, inequilateral, slightly inequivalve, usually subtrigonal, the posterior end longer; valves closed, the ligament and resilium adjacent and internal; hinge with three cardinals in the right valve, of which the posterior is more or less effaced by the resilium, and two in the left valve; the anterior edge of the right and the posterior edge of the left hinge margin grooved to receive the edge of the opposite valve, which is beveled to serve as a lateral lamina; sculpture chiefly concentric and often obsolete except near the umbones. (After Dall.)

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[1] *Gauldia* C. L. Boneparte, Consp. Gen. Avium, Vol. 1, p. 86, 1850. Adams originally included but two species in *Gouldia* (1847), the first, *G. cerina* C. B. Adams, was chosen by Dall (see Proc. U. S. Nat. Mus., Vol. 26, p. 350, 1902) as type, which makes *Gouldia* a subdivision of the *Veneridæ*; the second is apparently a variety of *Crassinella lunulata*. Mr. E. G. Vanatta, of the Philadelphia Academy, kindly assisted with information and advice on the above matter. Since this discussion was written, Stewart has pointed out (Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 146, 1930) that Smith selected *T. parva* for the type (Challenger Rept., Vol. 13, Pt. I, p. 222, 1885). Smith's reiteration of the statement that he takes *parva* for the type of the genus whereas Dall takes *cerina* is as clear a designation as many others that are accepted. Children in citing a type sometimes says that Lamarck's type is some other species. However, as there is some doubt about it, we hesitate to make the change. Stewart's discussion is not clear, but apparently he did not make the change either.

[2] Dall (1903), p. 1476, renamed Guppy's shell *Crassatellites* (*Crassinella*) *guppyi*.

[3] We have not seen Krueger's work, and have therefore assumed that the species cited by Harris is included in the original list.

The type of the original *Crassatella* Lamarck, 1799, being a Mactroid shell, *Crassatellites* Krueger becomes the name for the group typified by *Crassatella gibbosula* Lamarck, a species of the Lutetian of France.[1]

Crassatellites antillarum (Reeve)

Plate 13, Figures *7a*, *7b*

Crassatella antillarum L. Reeve, Proc. Zool. Soc. London, Pt. 10, p. 44, November, 1842; Conchologia Iconica, Vol. 1, *Crassatella*, species 8, pl. 2, fig. 8, January, 1843.

Shell triangularly ovate, slightly gibbous, thick, and covered with a strong fibrous epidermis; interior deep chocolate-brown, white near the margin; umbones a little depressed, and faintly undulated; anterior side rounded, posterior rather angular. (Reeve.)

Type locality: Margarita Island, West Indies; Recent.

Pliocene or *Pleistocene:* Upper conglomerate member near El Boleo Mines, Santa Rosalia, east side of Lower California, Mexico, S. D. S. N. H. loc. 32 (collected by Marcel Touwaide).

Recent: West Indies, rare (Reeve; Dall).

This species has somewhat the shape of *C. densus* Dall, of the Oak Grove sands (lower or middle Miocene) of Florida. M. E. Touwaide collected a perfect right valve of a *Crassatellites* from the upper conglomerate member at the Boleo Mines, Lower California, which cannot be distinguished from *antillarum* as figured by Reeve. *Crassatellites digueti* Lamy (*undulata* Sowerby, 1832, not Say, 1824) of the Recent Gulf of California fauna is somewhat similar, but that species has a sharper posterior prolongation and less prominent umbones.

Crassatellites lomitensis Oldroyd

Crassatellites lomitensis I. S. Oldroyd, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 1, p. 10, pl. C, Feb. 20, 1924.

Type specimen: In the Los Angeles Museum.

Type locality: Near Lomita, Los Angeles County; Pleistocene.

Pleistocene: At the type locality (coll. by Mr. S. Maus Purple).

This is a rounded-triangular species with concentric sculpture over the entire surface of the valves. It has considerable height but the umbonal part of the valve is broad and rounded. The measurements were given as: length, 42 mm.; height, 34 mm.

In the Oldroyd Collection at Stanford University there are two broken valves "dredged off San Pedro" labeled *C. fluctuatus* Carpenter, which are about the size and shape of the type of *C. lomitensis*, but they lack the concentric riblets except on the umbones.

Crassatellites subgibbosus Hanna

Crassatellites subgibbosus G. Dallas Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, pp. 463, 464, pl. 28, figs. 1-4, March 23, 1926.

Type specimen: California Academy of Sciences, No. 1,818.

Type locality: Coyote Mountain, western Imperial County; Pliocene.

Pliocene: From the first narrow box canyon east of Alverson Canyon, Coyote Mountain, Imperial County (type locality, coll. by Hanna); from two small washes on the west side of a tributary to Alverson Canyon at the base of Coyote Mountain, west of the road from Coyote Wells to Carrizo Spring via Coyote Mountain, western Imperial County (Kew, English, and Buwalda collections).

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[1] This species is figured by Cossmann and Pissaro, Icon. Compl. Coq. Fos. Eoc. Enviv. Paris, Tome 1, pl. 29, figs. 96-7, 1906.

Hanna compared this species to *C. gibbosus* (Sowerby).[1] *C. subgibbosus* Hanna appears to be related to Sowerby's species, but has a less attenuated posterior prolongation, and in some respects resembles *C. antillarum* Reeve.

Superfamily CARDITACEA

Shells similar to those of the *Astartidæ* but with prominent radial sculpture and the posterior cardinal tooth elongated.

Family CARDITIDAE

Anterior cardinal tooth often obsolete, the posterior elongated parallel with dorsal margin of the shell and sometimes extending beyond the ligament.

Genus CARDITA Bruguière, 1792

Cardita Brugière, Encycl. Méth., Vers, Vol. 1, Pt. 2, p. 401, 1892; Lamarck, Mém. Soc. Hist. Nat. Paris, p. 86, 1799; Children, Quart. Jour. Sci., Lit., Arts, Vol. 14, p. 316, pl. 6, fig. 60, 1823; Stoliczka, Mem. Geol. Surv. India, Palæo. Indica, Vol. 3, p. 282, 1871; Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 698, Jan., 1903; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1411, 1903.

Cyclocardia Conrad, Amer. Journ. Conch., Vol. 3, p. 191, 1867.

Type (by subsequent designation, Children, 1823) *Cardita sulcata* Bruguière, Ency. Méth., Vol. 1, p. 405, 1792, = *Chama antiquata* Linnæus, Syst. Nat., Ed. 10, p. 691, 1758, fig. by Bucquoy, Dautzenberg and Dollfus, Moll. Mar. Roussillon, Vol. 2, fasc. 6, pl. 38, figs. 1-9, 1892; Mediterranean, Recent.

Shell rounded-trigonal, strongly radially ribbed, the ribs frequently beaded, especially when young, the lunule minute and deep, the escutcheon linear, the internal margins crenate, the hinge with two transversely striated cardinals in the left and three in the right valve, the laterals absent or obsolete, a sub-lunular pustule sometimes present in the left valve. (Dall, describing *Venericardia.*)

Cardita is rounded or rounded-trigonal in shape and the lateral teeth are generally absent, whereas *Glans* is elongate and subquadrate or modioliform in shape, and the lateral teeth are more apt to be present. Examination of specimens of *Cardita antiquata* (Linnæus) has shown that a number of Pacific Coast Recent species must be considered typical and that *Cyclocardia* is probably not even sectionally distinct. Children's type designation makes the name *Cardita* apply to this group, recently called *Venericardia;* and the species recently called *Cardita* must be transferred to *Glans.*

Cardita ventricosa Gould

Plate 13, Figures 9*a*, 9*b*, 11

Cardita ventricosa Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 276, 1850; U. S. Expl. Exped., Vol. 12, p. 417, 1852, Mollusca Atlas, pl. 36, fig. 532, 1856.

Cardita monilicosta Gabb, Proc. Acad. Nat. Sci. Phila., p. 371, 1861; Geol. Surv. Calif., Palæo., Vol. 2, p. 101, 1868-9.

Venericardia borealis var. *ventricosa* Gould, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 269, 1888.

Venericardia ventricosa Gould, Stearns, Proc. U. S. Nat. Mus., Vol. 13, pp. 216, 217, pl. 16, figs. 5, 6, 1890; Dall, in Spurr, Twentieth Ann. Rept. U. S. Geol. Surv., Pt. 7, p. 264, 1900; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 190, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 128, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; Dall, U. S. Nat. Mus., Bull. 112, p. 32, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 114, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Venericardia (*Cyclocardia*) *monilicosta* Gabb, Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 709, January 20, 1903.

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[1] *Crassatella gibbosa* Sowerby, Proc. Zool. Soc. London, for 1832, p. 56. This species was reported from the late Tertiary of Zorritos, Peru, by Nelson, Trans. Conn. Acad. Arts and Sci., Vol. 2, Pt. 1, p. 203, pl. 7, fig. 9, 1871. Nelson's figure is strongly suggestive of *antillarum* Reeve.

Venericardia stearnsii Dall, Proc. Acad. Nat. Sci. Phila. for 1902, pp. 709, 714, January 20, 1903; Dall, Washington Acad. Sci., Alaska, Results Harriman Alaska Exped., Vol. 4, p. 121, 1904, reissued by Smithsonian Institution, 1910; Dall, U. S. Nat. Mus., Bull. 112, p. 31, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 112, 1924.

Venericardia californica Dall, Trans. Wagner Free Inst. Sci., Vol. 3, p. 1431, pl. 56, fig. 16, 1903; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Waterfall, Vol. 18, pp. 77-9, 1929.

Venericardia monilicosta Gabb, Arnold, U. S. Geol. Surv., Bull. 321, p. 80, pl. 14, fig. 2, 1907.

Venericardia castor Dall, U. S. Geol. Surv., Prof. Paper 59, p. 116, pl. 11, figs. 1, 3, 1909.

Miocene: Clallam County, Washington (Dall, as *castor*); Foxin's, Santa Barbara County; Santa Monica, Los Angeles County (Cooper); Cape Yaktag, Alaska (Dall, 1900).

Pliocene: Lower Fernando of Elsmere and Holser Canyons, Los Angeles County (English); San Fernando, Los Angeles County (Cooper); S. D. S. N. H. loc. 217, divide between Holser and San Martinez Chiquito Canyons, Los Angeles County, middle Pico; and ridge over San Fernando Pass railroad tunnel (loc. 214), middle Pico (coll. by H. R. G.); five miles south of Guadalupe, Santa Barbara County (Dall, 1903); Pico near Ventura (Waterfall); Packard's Hill, Santa Barbara (Arnold); S. D. S. N. H. loc. 39, south slope of Packard's Hill, abundant (U. S. G.); Bath-house Beach, Santa Barbara (Berry); S. D. S. N. H. loc. 218, Santa Barbara zone, Ventura Co.

Pleistocene: "Pliocene" of Deadman Island and Timm's Point, and lower San Pedro series of Deadman Island (Arnold); lower San Pedro fauna of Nob Hill, San Pedro (T. S. Oldroyd); Pacific Beach Pleistocene, San Diego (Arnold); lower Pleistocene of Ventura County.

Recent: Belkoffski Bay, Alaska, to Coronado Islands near San Diego, and Cortez Bank, California (Dall, 1921).

This is the common Pliocene and Pleistocene *Cardita* of California. It is characterized by the prominence of its umbones, which give it a subtrigonal shape, at least dorsally. The inner margins of the valves have prominent, squarish, widely-spaced crenulations corresponding to the external ribs. *C. californica* (Dall) is a superfluous name based upon wide, squarish-ribbed individuals, and *C. castor* (Dall) is doubtfully distinct. *Cardita subtenta* Conrad,[1] a Miocene fossil, appears to have more central beaks and may be specifically distinct. It is an earlier named species than *ventricosa*.

In 1903 Dall sought to prove that Gould's two type specimens of *Cardita ventricosa*, both from the Recent fauna of Puget Sound, represented two distinct species. According to Dall, the specimen figured by Gould in the Exploring Expedition Atlas is a more rounded "species" with more ribs (20-21) than the other which has higher umbones and fewer ribs (19). Dall named the high-beaked form *stearnsii*. A careful study of a series of Recent specimens from Puget Sound shows so great a variation in number of ribs that this character is certainly unreliable for specific distinction in the present case. The high-beaked form occurs along with the rounded form, but is rarer in the Recent fauna, if specimens in the Oldroyd Collection can be used as an index of relative abundance. In the Pleistocene fauna both the high-beaked and the rounded form occur together in the same matrix, but the form with prominent umbones is more common. In both the Recent and fossil collections the two extremes intergrade. Moreover, the occurrence of the high umbo is sporadic and not in any constant relationship to the number of ribs. In view of the apparent intermingling and intergrading of these characters, we consider *stearnsii* (Dall) and *ventricosa* Gould merely as extreme individual variants of one species.

Cardita crebricostata (Krause)

Venericardia crebricostata Krause, Arch. für Naturg., Vol. 51, Heft 1, p. 30, pl. 3, fig. 4, 1885; Dall, Bull. 112, U. S. Nat. Mus., p. 31, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 114, pl. 13, fig. 12, 1924.

"*Venericardia borealis* Conrad," Stearns, Proc. U. S. Nat. Mus., Vol. 13, pp. 215, 216, in part, pl. 16, fig. 8, 1890; also of some other early Pacific coast authors.

Venericardia (Cyclocardia) alaskana Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 710, January 20, 1903.

Venericardia alaskana Dall, in Moffit, U. S. Geol. Surv., Bull. 533, pp. 45-47, 1913.

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[1] U. S. Explor. Exped., Vol. 10, p. 726, 1849, Atlas, pl. 18, fig. 12.

Type specimen: In Stuttgart Royal Collection, *fide* Oldroyd.

Type locality: St. Paul Island, Alaska, *fide* Oldroyd.

Pliocene: Otter Creek; Center Creek; second beach one and a half miles east of Nome; and questionably from the submarine beach one-fourth mile west of the Snake River, all in Alaska (Dall, 1913).
Recent: Point Barrow, Alaska, to Monterey, California.

This species is ovate, somewhat flattened, and similar to *borealis* Conrad. The hinge is well figured by Stearns (1890).

Cardita crassidens (Broderip and Sowerby)

Astarte crassidens Broderip and G. B. Sowerby, Zool. Journal, Vol. 4, no. 15, p. 365, January, 1829.
Venericardia crassidens Broderip and Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 949, pl. 63, fig. 9, 1903; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 45, 1913; Bull. 112, U. S. Nat. Mus., p. 32, 1921.

Pliocene: Otter Creek, two miles from the coast, Nome district, Alaska (Dall, 1913).
Recent: Arctic and Bering seas and eastward to Kodiak Island, Alaska.

Dall figured and discussed this species at length in 1903. According to him it has nearly obsolete ribs and very anterior beaks.

Cardita barbarensis (Stearns)

Venericardia barbarensis Stearns, Proc. U. S. Nat. Mus., Vol. 13, pp. 214, 215, pl. 16, figs. 3, 4, 1890; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 128, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 31, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 111, pl. 43, figs. 9, 11, 1924.
Venericardia (Cyclocardia) barbarensis Stearns, Dall, Proc. Acad. Nat. Sci. Phila., 1902, p. 708, 1903.

Type specimen: U. S. National Museum, No. 104,045.

Type locality: Off Santa Barbara, California; Recent.

Pliocene: Santa Barbara formation, upper Pliocene, west of Bath-house Beach, Santa Barbara (Arnold, as "Pleistocene").
Pleistocene: "Pliocene" and lower San Pedro series, of Deadman Island, "common"; "Pliocene" at Timm's Point, "rare"; upper San Pedro series of Crawfish George's and San Pedro (Arnold).
Recent: Santa Barbara Channel to San Diego, California, in deep water (Dall, 1921).

This species has much less prominent umbones, a thinner, more elongate hinge, and more ribs than *ventricosa* Gould. It appears to be closer to *crebricostata* (Krause) and may be a southern race of that northern species. The hinge is well figured and discussed by Stearns.

Cardita nuwokensis (Dall)

Venericardia nuwokensis Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 33, pl. 5, fig. 14, 1920.

Pliocene: Carter Creek, Camden Bay region, Arctic coast (Dall).

According to Dall, this is a small, high, short species with about twenty nodulose ribs. We have not seen specimens.

Cardita yatesi (Arnold)

Venericardia yatesi Arnold, Smiths. Misc. Coll., Vol. 50, Pt. 4, pp. 21-22, pl. 58, figs. 2*a*-*b*, 1907.

Pliocene: Bath-house Beach outcrop, Santa Barbara upper Pliocene (Arnold).

This species is like *incisa* (Dall), but has fewer ribs (8 in *yatesi*, 19 in *incisa*), which are also wider.

Cardita crassicostata (Sowerby)

Venericardia crassicostata G. B. Sowerby, Cat. Shells Tankerville, Appen. 4, 1825; Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 707, Jan., 1903; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Venericardia flammea H. Michilin, Magasin de Zool., Vol. 1, p. 6, 1831.

Cardita flammea (Mich.) L. Reeve, Conch. Icon., Vol. 1, *Cardita*, pl. 8, fig. 38, 1843.

Pliocene: Coronados Island, Gulf of California, Mexico (Hanna and Hertlein).

Recent: Gulf of California, Mexico, southward to the Galapagos Islands (Dall, 1903).

This is a large, heavy species with very prominent umbones. It measures about 60 mm. in height and nearly that much in length. It is relatively higher and with more prominent beaks than *C. cuvieri* Broderip.

Cardita cuvieri Broderip

Cardita cuvieri W. J. Broderip, Proc. Comm. Sci. Zool. Soc. London, Pt. 17, p. 56, June, 1832; Reeve, Conch. Icon., Vol. 1, *Cardita*, pl. 5, fig. 24, 1843.

Venericardia cuvieri Broderip, Dall, Acad. Nat. Sci. Phila., 1902, p. 708, 1903.

Pleistocene: Upper Pleistocene, coast of Oaxaca, Mexico (coll. by R. H. Palmer).

Recent: Gulf of Fonseca south to Panama (Dall).

C. cuvieri Broderip is large, heavy-shelled, with broad, nodulous ribs separated by channeled interspaces. The beakes are strongly prosogyrous and much less erect than in *C. crassicostata* (Sowerby). Both species are well figured by Reeve.

There are a number of Carditas in the earlier Tertiary, as well as in the Recent fauna, which cannot be discussed here. The "*Cardium*" *aleuticum* Girard,[1] from the Tertiary of Atcha Island, Alaska, is a small species (1½ inches) with the general shape of a *Glycymeris*, but with pointed beaks and sculpture something like that of small Carditas. The hinge is unknown, and the similarity of the figure to a specimen of a *Cardita* from Nunivak Island, Alaska, in the Oldroyd Collection, which may be *crebricostata* (Krause), suggests that Girard's species may belong to the latter genus. It is an early described species.[2]

Subgenus **MIODONTISCUS** Dall, 1903

Miodon Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 611, 627, 642, 682, 1864; Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 424, Dec., 1864; Dall, Acad. Nat. Sci. Phila., for 1902, p. 700, 1903; not *Miodon*, Sandberger, 1870 = *Miodontopsis* Dall; nor *Miodon* Duméril, 1859.

Miodontiscus Dall, Nautilus, Vol. 16, p. 143, April, 1903, new name for *Miodon* Carpenter, 1864, not Duméril, 1859.

Type (by subsequent designation, Dall,[3] 1903), *M. prolongatus* Carpenter.

Shell small, ovate-trigonal, not compressed, posterior right cardinal absent, posterior right and anterior left laterals developed feebly. (After Dall.)

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[1] A. Erdman's Archiv Wiss. Kunde Russlands, Vol. 3, p. 546, figs. 9*a*, 9*b*, 1843; original figures and description reproduced by Grewingk, Russiaich-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for 1848 and 1849, p. 350, pl. 5, figs. 4*a*, 4*b*, 1850. Dall reported the species from the Miocene of Cape Yaktag, Alaska, *vide* Spurr, 20th Ann. Rept. U. S. Geol. Surv., Pt. 7, p. 264, 1900.

[2] Eichwald, p. 125, 1871, attributes this species to the Cretaceous. He calls it *Pectunculus aleuticus* and thinks that *kashewarowi* may be a synonym. See the note to *Mya arenaria* variety *profundior*, p. 414. A later view of Grewingk' figure has convinced the present writers that the species is a *Glycymeris*, for some of the taxodont teeth are showing.

[3] Although it is very evident that Carpenter founded *Miodon* on *M. prolongatus* Carpenter, he mentions other species as being congeneric, hence the subgenus is not monotypical.

Cardita (Miodontiscus) prolongata (Carpenter)

Miodon prolongatus Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864; Ann. Mag. Nat. Hist. Ser. 3, Vol. 14, p. 424, December, 1864; Stearns, Proc. U. S. Nat. Mus., Vol. 13, p. 217, pl. 16, figs. 7, 9, 1890.
Venericardia (Miodon) prolongatus Carpenter, Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 711, Jan. 20, 1903.
Miodontiscus prolongatus Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 32, 1921.
Venericardia (Miodontiscus) prolongata Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 115, pl. 2, figs. 5, 6, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925.

Type specimen: In the U. S. National Museum.

Type locality: Near Neah Bay, Washington, Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill, San Pedro (T. S. Oldroyd); Pleistocene of San Diego (Oldroyd Collection, Stanford University).
Recent: Middleton Island, Alaska, to San Diego, California (Dall, 1921).

This is a small shell, about 5 mm. high and 5 mm. long. The low radial ribs are few in number and are intersected at wide regular intervals by concentric incised lines as on *C. incisa* (Dall). The beaks are erect and rather prominent.

Genus VENERICARDIA Lamarck, 1801

Venericardia Lamarck, Syst. Anim. sans Vert., p. 123, 1801; Gray, Proc. Zool. Soc. London, Pt. 15, p. 193, 1847; Herrmannsen, Indicis Gen. Malac., Vol. 2, p. 680, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1408, 1416, 1903.

Type (by subsequent designation, Gray, 1847), "*V. imbricata*" (*Venus imbricata* Gmelin, Syst. Nat., Ed. 13, Vol. 1, p. 3277, 1790, Eocene of Paris Basin; figured by Cossmann and Pissaro, Icon. Coq. Eoc. Env. Paris, Vol. 1, pl. 31, fig. 97-4, 1906).

Children's designation of the type of *Cardita* brings that name closer to *Venericardia*. It is probable that the latter should be considered only a subgenus. *V. imbricata*, the type of *Venericardia*, is more orbicular in outline than the well-known ovate-trigonal *planicosta* Lamarck, and does not have such a massive hinge as the latter. Hence *planicosta* may not be any more closely related to *Venericardia* than to *Cardita* and should perhaps be assigned to some other subgenus of *Cardita*. The Recent typical species of *Cardita* differ from *planicosta* chiefly in size.

Genus GLANS Megerle von Mühlfeld, 1811

Cardita Bruguière, 1792, in part, not the type.
Glans Megerle von Mühlfeld, Gesellschaft naturforschender Freunde zu Berlin, Magazin, Year 5, p. 68, 1811; Cossmann and Peyrot, "Conchologie Néogénique de l'Aquitaine," Actes de la Société Linnéenne de Bordeaux, Vol. 66, p. 31, 1912; Woodring, Carnegie Inst. Wash., Publ. No. 366, p. 99, 1925.

Type (by monotypy) *Chama trapezia* Linnæus, Syst. Nat., Ed. 12, p. 1138, 1767; figured by Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 231, pl. 38, figs. 21, 22, 23, 24, 25, 1892, and by Cossmann and Peyrot, *op. cit.*, p. 31, text fig. 5, p. 41, pl. 2, figs. 23-26, (27-30 ?), 1912; Mediterranean, Recent.

Shell similar to that of *Cardita*, but more quadrate in shape and usually with well-developed anterior laterals.

Geologic range: Mesozoic to Recent.

This genus is closely related to *Cardita*, with which it intergrades; but the difference in shape is so distinctive that it is easy to separate most of the species that were once assigned to *Cardita* into two well-defined groups. The development of the lateral teeth is probably only a function of the change in shape, for in some species of *Cardita* rudimentary laterals are present.

The common California species *minuscula* appears to be very much like the type of *Glans* and is here tentatively considered typical. The more southerly *affinis* is hardly more than sectionally different. It can probably be placed in *Carditamera*. Stewart has shown[1] that the Mediterranean *Glans calyculata* (Linnæus),[2] formerly considered the type of *Cardita*, can be assigned to the section *Mytilicardita* Anton, 1839, of which it is the type. These sections may be distinquished as follows:

Glans, *s. s.*	Small, short, quadrate; laterals strong.
Carditamera	Large, elongate-quadrate; laterals strong.
Mytilicardita	Elongate-quadrate; laterals obsolete in adult.

It is probably better to use *Mytilicardita* for the last group than *Arcinella* Oken, 1815, which was suggested by Stewart, for the type of the latter may be *Chama arcinella* Linnæus, by absolute tautonymy.

Glans minuscula, new species

Plate 13, Figures 10*a*, 10*b*

Lazaria subquadrata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 536, 627, 642, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 178, March, 1865; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 244, 1888; Keep, West Coast Shells, p. 179, fig. 152, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 190, 1892; Newcombe, Nautilus, Vol. 10, p. 19, 1896; Baker, Nautilus, Vol. 16, p. 43, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 129, 1903; not *Cardita subquadrata* Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 3, p. 298, 1848; Jour., Ser. 2, Vol. 1, p. 128, pl. 14, fig. 10, 1848; nor *Cardita subquadrata* Gabb, Jour. Acad. Nat. Sci. Phila., Ser. 2, Vol. 4, p. 303, pl. 48, figs. 22*a*, 22*b*, 1860, = *Cardita perantiqua* Conrad, *fide* Whitfield, U. S. Geol. Surv., Mon. No. 9, p. 232, 1885, Eocene of New Jersey.

Cardita (*Carditamera*) *subquadrata* Carpenter, Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 707, 1903.

Cardita subquadrata Carpenter, E. P. and E. M. Chace, Lorquinia, Vol. 2, no. 6, p. 42, Jan., 1919; Dall, Bull. 112, U. S. Nat. Mus., p. 31, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 110, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 4, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Shell small, subquadrate, with about fourteen to sixteen strong, rounded, somewhat beaded radial ribs separated by narrow interspaces. Length, average about 10 or 12 mm., height, 6 or 7 mm.

Type specimen: No. 126 in the type collection of the San Diego Society of Natural History.

Type locality: Locality 78, S. D. S. N. H., Upper Pleistocene terrace near Seacliff, Ventura Co.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro, "about 30 valves" (T. S. Oldroyd); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan, 1924); the Chiton bed at Pt. Firmin, Los Angeles County (Chace); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926); Pleistocene terrace near Seacliff Station on Southern Pacific R. R., eight miles northwest of Ventura.

Recent: Queen Charlotte Islands, British Columbia, to Todos Santos Bay, Lower California.

This species is much smaller and more quadrate than *G. laticostata* (Sowerby), 1832, of the Panamic fauna. *G. radiata* (Sowerby), 1852, of the west Mexican coast, is larger and more elongate.. *G. affinis* (Sowerby), 1832, is somewhat similar in shape, but very much larger (length 45 mm. and over) and the ribs are entirely different. *G.*

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[1] Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 149, 1930.

[2] *Chama calyculata* Linnæus, Syst. Nat., Ed, 10, p. 692, 1758; figured by Reeve, Conch. Icon., Vol. 1, *Cardita*, pl. 1, fig. 1, 1843, by Fischer, Man. Conch., p. 1012, pl. 20, fig. 5, 1887, and by Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, pl. 38, figs. 10-13, 1892.

guppyi (Dall) (Trans. Wagner Inst. Sci., Vol. 3, p. 1413, pl. 56, fig. 3, 1903) of the Pliocene of Trinidad, judging from Dall's figure, is strikingly similar and may be closely related to *minuscula*.

Carpenter's specific name being preoccupied, we have proposed a new one. Carpenter's assigning this species to *Lazaria* instead of *Cardita* might have saved the name; but it appears that Conrad's *subquadrata*, though probably not Gabb's, should also be assigned to *Glans*.

Section CARDITAMERA Conrad, 1838

Carditamera Conrad, Fossils of the Medial Tertiary of the United States, No. 1, p. 11, pl. 6, fig. 2, January, 1838, republished with introduction by Dall, Wagner Free Inst. Sci., 1893; Dall, Proc. Acad. Nat. Sci. Phila. for 1902, p. 698, 1903; Trans. Wagner Inst. Sci., Vol. 3, p. 1412, 1903.
Lazaria Gray, Ann. Mag. Nat. Hist., Vol. 14, p. 22, 1854.
Lazariella Sacco, Bolletino Mus. dei Zoologia, Torino, Vol. 14, No. 349, p. 112, 1899, *fide* Dall, 1903.

Type (by monotypy), *Cardita arata* Conrad (figured by Conrad, Foss. Shells Tert. Form., No. 1, pl. 5, fig. 1, 1832; Foss. Med. Tert., pl. 6, fig. 2, 1838); Miocene of New Jersey, Maryland, Virginia, etc., Pliocene of Florida.

Valves with the laterals well developed in the adult, the right anterior cardinal often obsolete. (Dall.)

Glans affinis (Sowerby)

Cardita affinis G. B. Sowerby, Proc. Comm. Sci. Zool. Soc. London, p. 195, March, 1833; Reeve, Conch. Icon., Vol. 1, *Cardita*, sp. 6, pl. 1, fig. 6, 1843.
Cardita (*Carditamera*) *affinis* Sowerby, Dall, Proc. Acad. Nat. Sci. Phila., for 1902, p. 706, 1903.

Pleistocene: Coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Margarita Bay on the west coast of Lower California, Mexico, the Gulf of California, and southward to Panama.

This is a large (45 mm. length), elongate species with relatively few, broad ribs which may be very low or almost obsolete on the anterior portion of the shell. The specimens obtained by Palmer might be variety *californica* (Deshayes), 1852, which is said to be larger and darker colored.

Genus CALYPTOGENA Dall, 1891

Calyptogena Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 189, 1891; Vol. 17, p. 713, 1895; Proc. Acad. Nat. Sci. Phila. for 1902, p. 700, 1903; Trans. Wagner Inst. Sci., Vol. 3, p. 1435, 1903.

Type (by monotypy), *Calyptogena pacifica* Dall, *op. cit.*, 1891.

Shell ovate, smooth, without radiating sculpture and covered by a conspicuous epidermis; valves closing hermetically; non-byssiferous; the pallial line simple, the basal margin flat and entire. Shell without a lunule but with a long excavated escutcheon; the ligament deep-seated but practically external. Hinge in the right valve with a Λ-shaped socket and a triangular cardinal tooth below it, behind which is a short, feeble, narrow, lateral tooth; in the left valve a Λ-shaped cardinal and posterior lateral. The teeth become more or less obsolete in old shells. The mantle edge is minutely fringed, the siphonal openings papillose, the foot stout, blunt, ovate cylindrical. The shell is earthy in texture. (Dall.)

Calyptogena pacifica Dall

Plate 13, Figures 13*a*, 13*b*

Calyptogena pacifica Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 190, 1891; Vol. 17, p. 713, pl. 25, figs. 4, 5, 1894; Proc. Acad. Nat. Sci. Phila. for 1902, p. 712, Jan., 1903; Trans. Wagner Inst. Sci., Vol. 3, p. 1435, 1903; U. S. Nat. Mus., Bull. 112, p. 32, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 116, 1924.

Type specimen: In the U. S. National Museum.

Type locality: Off Dixon Entrance, Alaska, in 322 fathoms.

Pliocene: Los Angeles, California (Dall, 1903); blown out of big Amalgamated Gas well, from depth of 2500 feet with *Dendraster interlineatus* Stimpson, Wolfskill lease, Salt Lake oil field, near Beverly Hills, Los Angeles County (coll. by J. O. Lewis, 1912).

Recent: Clarence Strait, Alaska, to Santa Barbara Channel, California (Dall, 1921).

In shape this species resembles somewhat a *Petricola.* It is elongate, with an anterior, moderately prominent beak. There is no sculpture except growth lines. *C. elongata* Dall[1] is more elongate, compressed, and thinner shelled. It is the southern form of the type species, and should probably be listed as a variety.

Superfamily CHAMACEA

Family CHAMIDAE

Shell inequivalve, thick, attached or free in young or adult stages; beaks subspiral; ligament external; adductor impressions large, reticulated, pallial line simple.

Geologic range: Cretaceous to Recent (Odhner).

Genus CHAMA Linnæus, 1758

Chama Linnæus, Syst. Nat., Ed. 10, p. 691, 1758; Children, Quart. Jour. Sci., Lit., Arts. Vol. 15, p. 28, pl. 1, fig. 74, April, 1823; Odhner, Kungl. Vetens. Handl., Vol. 59, No. 3, 1919.

Type (by subsequent designation, Children, 1823), *Chama lazarus* Linnæus, figured by Reeve, Conch. Icon., Vol. 4, *Chama*, pl. 2, figs. 4*a*-*b*, 1846.

Shell attached by the left valve, which is generally the larger; adductor impressions large; sculpture foliaceous or spinose.

The hinge teeth in this genus are only observable in the young stages; later they are replaced by rather crude and heavy rugosities arranged nearly parallel to the hinge margin.

Chama pellucida Broderip

Chama pellucida Broderip, Proc. Zool. Soc. London, Vol. 2, p. 149, 1835; Trans. Zool. Soc. London, Vol. 1, p. 302, pl. 38, fig. 3, 1835; Reeve, Conch. Icon., Vol. 4, *Chama*, sp. 32, pl. 6, fig. 32, 1847.

Chama pellucida Sowerby, Keep, West Coast Shells, p. 182, fig. 155, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 189, 1892; Cooper, Calif. State Mining Bureau, Bull. 4, p. 24, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 130, 1903; Keep, West Amer. Shells, p. 59, fig. 46, 1904; Arnold, U. S. Geol. Surv., Bull. 396, p. 158, pl. 26, figs. 5, 6, January 15, 1910; Arnold and R. Anderson, Bull. 398, pp. 125, 332, pl. 48, figs. 5, 6, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 417, 1914; Odhner, Kungl. Svensk. Vetenskaps-akad. Handl., Vol. 59, No. 3, p. 62, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 33, Feb. 24, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 118, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Miocene: Lower San Pablo of middle California (Clark, 1914).

Pliocene: Pliocene of Ventura County (Stephen Bowers); upper Etchegoin of Coalinga region (Arnold and R. Anderson); common in *Pecten coalingensis* zone of the Etchegoin formation (Nomland); upper Pico near Ventura (Waterfall).

Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles County (Arnold, 1903); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan, 1924); rare in the upper San Pedro of San Pedro, Deadman Island, Los Cerritos, and Crawfish George's, Los Angeles County (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Oregon to Chile and the Galapagos Islands (Dall, 1921).

This is the common California *Chama.*

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[1] Proc. U. S. Nat. Mus., Vol. 52, p. 408, 1916, figured in Bull. 112, U. S. Nat. Mus., p. 23, pl. 3, fig. 3, Feb., 1921.

Chama frondosa Broderip

Chama frondosa W. J. Broderip, Proc. Zool. Soc. London, Vol. 2, p. 148, April, 1835; Trans. Zool. Soc. London, Vol. 1, p. 302, pl. 38, figs. 1, 2, 1835; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 262, 1909; Lamy, Jour. Conchyl., Vol. 57, p. 236, 1909; Bull. 112, U. S. Nat. Mus., p. 33, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 118, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 463, 1926; E. K. Jordan, Vol. 15, p. 427, pl. 34, fig. 1, 1926.

Chama parasitica de Rochebrune, Bull. Mus. Hist. Nat. Paris, Vol. 1, p. 243, 1895, *fide* Lamy, 1909.

Type specimen: In the British Museum.

Type locality: Island La Plata, West Colombia.

Pliocene: Coyote Mountain, western Imperial County (Hanna); Pliocene of Cedros Island and of Turtle Bay, Lower California, Mexico (Jordan and Hertlein).
Recent: San Diego, California, to Peru.

This is a larger species than *Chama pellucida.*

Chama buddiana C. B. Adams

Chama buddiana C. B. Adams, Annals of Lyceum of Natural History of New York, Vol. 5, p. 253 (of the separate), 1852; Dall, Bull. 112, U. S. Nat. Mus., p. 33, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 119, 1924; E. K. Jordan, Proc., Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the collection at Amherst College.

Type locality: Panama; or Guaymas, Mexico; Recent.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California, to Panama.

Described as having small, thick, dentiform white spines. The specimens we have examined have been worn and lack the projecting spines.

Genus ECHINOCHAMA Fischer, 1887

Echinochama Fischer, Man. Conchyl., p. 1049, 1887; Woodring, Carnegie Inst. Publ., No. 366, p. 105, 1925.

Type (by monotypy), *Chama arcinella* Linnæus; West Indies, Recent and fossil.

Young shell attached by right valve; adults not attached.

Woodring (1925) has stated that *Echinochama* is a strictly American tropical group of Chamas. On the Pacific coast the genus is represented by *Echinochama californica* Dall, which occurs in the Recent fauna of the Gulf of California and at Cedros Island. In the Caribbean region the genus first appears in the lower Miocene (Cercado formation of the Dominican Republic). The genotype, *E. arcinella* (Linnæus), lives in the West Indies.

Echinochama Fischer differs from *Chama* Linnæus in that the shell is attached by the right valve in early stages and when adult is not attached. The right valve often shows a place where it was originally attached. The umbones being strongly prosogyrous, the right and left valves are readily distinguished.

Genus PSEUDOCHAMA Odhner, 1917

Pseudochama Odhner, Kungl. Svenska Vetenskaps-akademiens Handlingar, Vol. 52, No. 16, pp. 28-31, 1917; Vol. 59, No. 3, pp. 20, 23, 1919.

Typical example[1]: *Pseudochama cristella* (Lamarck); Australian waters; Recent.

Shell attached by the right valve; not free in adult stage.

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[1] The original description of *Pseudochama* Odhner, 1917, has not been seen by the authors. *P. cristella* Lamarck is in Odhner's original list.

Pseudochama exogyra (Conrad)

Chama exogyra Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 256, 1837; Reeve, Conch. Icon., Vol. 4, *Chama*, sp. 38, pl. 7, fig. 38, 1847; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 233, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 189, 1892; Cooper, Bull. Calif. State Mining Bureau, No. 4, p. 24, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 130, 1903; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 119, 1924.

Pseudochama exogyra Conrad, Dall, U. S. Nat. Mus., Bull. 112, p. 33, 1921; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: Santa Barbara, California; Recent.

Pliocene: Upper Pico, Santa Barbara horizon, upper Pliocene, near Ventura (Waterfall).
Pleistocene: Santa Barbara to San Pedro (Cooper); upper San Pedro series of San Pedro and Los Cerritos (Arnold); San Nicholas Island (Bowers).
Recent: Oregon to Panama.

This species has lower, shorter sculpture than *C. pellucida* and is generally larger and heavier shelled. It is further distinguished by being attached by the right valve. Collections usually contain only specimens that had become loose and were subjected to erosion before being found.

Superfamily CODAKIACEA

Family THYASIRIDAE

Valves equal, free, closed, with a posterior radial flexure; hinge edentulous or with an obscure right cardinal; ligament and resilium behind the beaks, sub-external; pallial line entire.

Genus THYASIRA Leach in Lamarck, 1818

Thyasira Leach MS., Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 492, 1818; Dall, Trans. Wagner Free Inst. Sci., Vol. 3, pp. 1335-1338, 1903.

Conchocele Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 27, 1866.

Schizothærus Locard, Ann. Univ. Lyons, p. 180, 1896; not of Conrad, 1853.

Type (by monotypy, *fide* Dall, 1903), *Tellina flexuosa* Montagu, 1803 (figured by Forbes and Hanley, Hist. Brit. Moll., Vol. 2, pp. 54, 55, pl. 35, fig. 4, 1852).

Smooth, thin-shelled, typically small.

Geologic range: Cretaceous to Recent.

Conchocele Gabb, based upon *Thyasira disjuncta* (Gabb), differs from *Thyasira* only in the size of the respective type species.

Thyasira bisecta (Conrad)

Compare Plate 13, Figure 15

Venus bisecta T. A. Conrad, U. S. Expl. Exped. (Wilkes), Vol. 10, Geol., p. 724, October, 1849, Geol. Atlas, pl. 17, figs. 10, 10*a*, 1849.

Cyprina bisecta Conrad, Amer. Jour. Conch., Vol. 1, p. 153, 1865.

Conchocele disjuncta Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 28, 1866, p. 99, pl. 7, figs. 48*a-b*, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 236, 1888.

Conchocele bisecta Conrad, Gabb, *loc. cit.*, p. 99, 1868-9.

"*Cryptodon bisectus* Dall," Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 189, 1891; Vol. 17, p. 713, pl. 26, figs. 2, 5, 1895.

Thyasira bisecta Conrad, Dall in Spurr, U. S. Geol. Surv., 20th Ann. Rept., Pt. 7, p. 264, 1900; Dall, Proc. U. S. Nat. Mus., Vol. 23, pp. 789, 790, 1901; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 135, pl. 15, fig. 4, 1903; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 118, 1909; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 180, pl. 1, fig. 7, 1909; Weaver, Wash. Geol. Survey, Bull. 15, p. 18, 1912; Dall, U. S. Nat. Mus., Bull. 112, p. 33, 1921; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 306, 1922; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 120, pl. 10, fig. 1, 1924; Yabe and Nomura, Science Repts. Tôhoku Imper. Univ., Ser. 2 (Geol.), Vol. 7, No. 4, p. 84, pl. 33, figs. 2, 7-10, 1925; Hägg, Bull. Geol. Inst. Upsala, Vol. 20, p. 46, 1925; Tegland, Nautilus, Vol. 41, p. 129, 1928.

Thyasira disjuncta Gabb, Tegland, Nautilus, Vol. 41, p. 129, 1928; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type localities: Of *bisecta,* Miocene of Astoria, Oregon; of *disjuncta,* Deadman Island, San Pedro Harbor, Miocene according to Gabb, Pliocene according to Arnold, now considered Pleistocene.

Oligocene: Blakeley horizon, near Seattle (Arnold); Blakeley of western Washington (Weaver); Oligocene of San Emigdio region (coll. by O. P. Jenkins); etc.
Miocene: Astoria, Oregon (Conrad); "Miocene" of Cape Yaktag, Alaska (Dall, 1900); etc.
Pliocene: Wildcat beds of Scotia bluffs, Humboldt County (Stanford collection).
Pleistocene: Deadman Island, San Pedro Harbor (Gabb, as *disjuncta,* "Miocene"); "Pliocene" of Timm's Point, near San Pedro (Arnold, 1903).
Recent: Off Alaska Peninsula and southward to Oregon coast.

This species is large for the genus. Specimens sometimes attain a length of 130 mm. (about 5 inches). The anterior dorsal margin often forms a right or an acute angle at the umbo with the posterior dorsal margin. There seems to be considerable individual variation in this angle. Dall and others have considered Gabb's *disjuncta* conspecific with Conrad's *bisecta,* but recently Tegland (1928) has expressed the opinion that the Miocene *bisecta* Conrad is different, and that the Recent and Pleistocene form should take Gabb's name. Tegland distinguishes *bisecta* by the pronounced anterior projection of the margin of the valves immediately below the lunule. While the amount of anterior projection varies individually, the specimens at Stanford University from the Oligocene of the Olympic Peninsula and from San Emigdio, from the "Miocene" near Seattle, from the Pliocene Wildcat beds of Scotia bluffs, Humboldt County, from the Pleistocene of southern California, and Recent specimens, seem to be specifically identical. We have not seen specimens which entirely coincide with the anterior profile as figured by Conrad, as all our specimens are flat below the lunule or only moderately alate. We believe that Conrad had an abnormal specimen in that regard, and under the circumstances we use the oldest name for the form which appears to persist from the Oligocene to the Recent. The Oligocene and Recent specimens are closer in appearance than is Conrad's Miocene form to either.

The reader is referred to the interesting paper by Yabe and Nomura on the Japanese Recent and Tertiary species of *Thyasira.*

Thyasira gouldii (Philippi)

Lucina gouldii Philippi, Zeitschr. f. Malak., p. 74, 1845.
Cryptodon gouldii Philippi, Binney, in Gould's Invert. Mass., p. 100, fig. 406, 1870.
"*Cryptodon flexuosus* Montagu," Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 297, 1874; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 237, 1888, not of Montagu (?).
Thyasira gouldi Philippi, Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 135, 136, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 33, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 120, pl. 34, fig. 5, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: San Diego formation of the San Diego well in Balboa Park, San Diego (Dall, 1874); Pliocene of Santa Barbara (Cooper); upper Pico, Pliocene, near Ventura (Waterfall).
Pleistocene: Deadman Island and Timm's Point, San Pedro region (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro, one valve (T. S. Oldroyd).
Recent: Bering Strait to San Diego, California; also Atlantic (Dall).

This species was first identified on the New England coast as *flexuosa* (Montagu) by Gould, Binney, and others, then separated by Philippi as a new species, *Lucina gouldii.* Later, Carpenter identified Montagu's *flexuosa* on the Pacific coast and this identification was accepted by Dall, Cooper, and others for many years. The differences are slight, and undoubtedly the English and the Pacific coast shells are closely related. Both are very small in comparison to the relatively enormous *bisecta.*

Family CODAKIIDAE

Genus CODAKIA Scopoli, 1777

Codakia J. A. Scopoli, Introd. Hist. Nat., p. 398, 1777, sole example, *Chama codak* Adanson, Hist. Nat. Senegal, Coq., p. 223, pl. 16, fig. 3, 1757 (original spelling *codok*), = ? *Venus punctata* Linnæus, *fide* Woodring, Carnegie Inst., Publ. No. 366, p. 107, 1925; Dall, Proc. U. S. Nat. Mus., Vol. 23, pp. 797, 798, 1901; Trans. Wagner Inst. Sci., Vol. 3, pp. 1344, 1345, 1903.

Shell rather large (often 90 to 100 mm. in height and slightly longer), discoidal, flattened, subcircular in outline, beaks small, not very prominent; sculpture consisting of radial riblets and small growth lamellæ; hinge plate strong, with deeply set ligament and the resilium posterior to the cardinal teeth; two well-developed cardinal teeth, the right anterior distant, fitting into a socket in the left valve; pallial line entire, often conspicuously impressed; anterior adductor scar elongate, crescentic.

Type (by monotypy), *Chama codak* Adanson = *Venus punctata* Linnæus.

This genus occurs largely in tropical and subtropical waters.

Codakia distinguenda (Tryon)

"*Lucina tigerina* Linnæus," of Carpenter, Stearns, Mabille, and of Pacific coast collectors, not *Venus tigerina* Linnæus, Syst. Nat., Ed. 10, p. 688, 1758, West Indies.

Lucina (*Codakia*) *distinguenda* Tryon, Proc. Acad. Nat. Sci. Phila. for 1872, p. 130, pl. 6, fig. 3.

Codakia colpoica Dall, Proc. U. S. Nat. Mus., Vol. 23, pp. 801, 821, pl. 41, fig. 4, 1901; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 463, 1926; Hanna and Hertlein, Vol. 16, p. 140, 1927.

Lucina (*Codakia*) *colpoica* Dall, Lamy, Jour. de Conchyl., Vol. 57, p. 238, 1909.

Type specimen: In the Academy of Natural Sciences of Philadelphia.

Type locality: Gulf of California, collected by W. M. Gabb.

Pliocene: Santa Antonita Point, Gulf of California, and of Coronados Island and Carmen Island, Mexico (Hanna and Hertlein); Coyote Mountain, Imperial County (Hanna).
Pleistocene: Santa Rosalia district, Gulf side of Lower California, Mexico, one valve (coll. by Marcel Touwaide); coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Lower California to Panama.

This is the only common species of the typical subgenus in Lower California waters. Tryon named the species almost thirty years before Dall. It is probable that *distinguenda* is conspecific with the analagous Caribbean form, having survived without appreciable change since the Miocene on both sides of the continent.

Genus LUCINA Bruguière, 1797

Lucina J. G. Bruguière, Encycl. Méth., Tabl. Vers, pl. 284, 1797, name and figures only, the figures later identified by Deshayes as *Lucina pensylvanica*, *jamaicensis*, and *edentula* (L.); Lamarck, Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 84, 1799, only species *L. edentula;* Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 165, 1817, type cited *Lucina pensylvanica;* Children, Quart. Jour. Sci., Lit., Arts, Vol. 14, p. 307, January, 1823, type cited *Lucina jamaicensis*, pl. 5, fig. 48; Dall, Proc. U. S. Nat. Mus., Vol. 23, pp. 801, 802, 1901; Trans. Wagner Inst. Sci., Vol. 3, pp. 1351, 1352, 1903; Iredale, Proc. Malac. Soc. London, Vol. 11, pt. 5, p. 302, 1915; Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 175, 1930.

Phacoides Blainville, Dict. Sci. Nat., Vol. 32, p. 334, 1824, vernacular use only; Manuel de Malac., Vol. 1, p. 550 (misprinted 450), 1825, vernacular use, only species *Lucina jamaicensis;* Gray, Proc. Zool. Soc. London for 1847, p. 195, 1847, type, *Venus jamaicensis;* Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 805, 1901; Trans. Wagner Inst. Sci., Vol. 3, pp. 1359, 1360, 1903; Iredale, Proc. Malac. Soc. London, Vol. 11, p. 301, 1915.

Type (by subsequent designation, Schumacher, 1817), *Venus pensylvanica* Chemnitz, Conch. Cab., Vol. 7, p. 12, pl. 37, fig. 394, West Indies, Recent.

Shell with subcircular outline, moderately inflated, valves closed, pseudo-lunule small, sometimes deeply impressed; sculpture generally concentric only, sometimes with radial ribs, a long radial sulcus or plication below the posterior dorsal margin (the escutcheon) and a shorter curved one anterior to the beaks (the lunule); hinge with small cardinal teeth, often obscure in adults, laterals sometimes well developed; pallial line entire.

As Lamarck's choice of a single species to illustrate the genus *Lucina* in his "Prodrome" cannot be taken as a type designation, the first to cite a type of *Lucina* was Schumacher, who definitely designated and figured the *Venus pensylvanica* of Chemnitz. As *jamaicensis*, which later became the type of *Phacoides*[1] through Gray's designation of 1847, belongs to the same section, the latter name becomes a synonym of *Lucina* Bruguière.

Codakia is closely related, but has a heavier hinge plate, the anterior teeth are generally closer to the cardinals, and the exteriors of the valves do not have the posterior plications that are so conspicuous on most species of *Lucina*.

The *Codakiidæ* are in need of a thorough revision, both nomenclatorial and morphologic; but lack of time and facilities makes it impracticable for the present writers to carry out now a sufficiently thorough review of the whole group to make it worth while. Because of its long standing and familiarity the genus name *Lucina* is used for most of the species included here in spite of the fact that typical *Lucina* is practically as distinct from most of the other subgenera as is *Codakia*, a genus with an older name. The name *Phacoides* applies to the same group as typical *Lucina* and is therefore of no value. Instead of recognizing all of the groups as subgenera of *Codakia* (they are all clearly rather closely related), it will probably be best eventually to treat all of the subgenera used below as distinct genera. However, until the nomenclature can be settled with reasonable certainty, it is probably better to retain the old arrangement than to introduce as full genera names that are subject to change. *Loripes* Poli, 1791, Oken, 1815,[2] is one of the old names that the writers have not been able to investigate.

The shells of the *Codakiidæ* have usually circular, saucer or cup-shaped valves, with radial or concentric sculpture, or both, two cardinal teeth in each valve, and more or less developed anterior and posterior laterals. Besides a large, rather ill-defined lunule, most of the species have a small, smooth depression immediately in front of the beaks which is often miscalled a lunule. A radial sulcus on the posterior part of the valves may be analagous to the escutcheon of other families. In typical *Lucina* the shell is heavy and perhaps as a consequence the lateral teeth are all well developed, and the posterior sulcus is very strong, as in *Thyasira*. The lunule-like depression appears to be entirely absent in *Lucina, s. s.*, and the sculpture is concentric. *Here* is thick shelled also and even more convex, with strong, rounded lateral teeth and concentric sculpture as in typical *Lucina;* but the lunule-like depression is deeply excavated and cave-like, crowding aside the cardinal teeth. The small cardinal teeth are oblique as in typical *Lucina* and the true lunule is large and rather obscure; but the posterior sulcus is very much weaker than in typical *Lucina*. In *Codakia* the valves are large and of low convexity, with both concentric and radial sculpture; the hinge is strong and concentrated, the anterior laterals are well developed, elongate, and close to the cardinals, but the posterior laterals have been crowded out by a very wide, shortened ligamental trough and have become obsolete. The pseudo-lunule is small but fairly deep; the true lunule and the escutcheon are faint. *Myrtea* is smaller than *Codakia*, with a relatively much longer and narrower ligamental trough, with small distant laterals becoming obsolete in some species, and a narrow, elongate pseudo-lunule. The sections of *Myrtea*, though distinguished by sculpture, appear to form a well-defined group of closely related species. Both *nuttallii* and *tenuisculpta* have the sculptural elements of *Codakia; californica* has closely packed concentric sculpture only; and *acutilineata* has distinct concentric lamellæ and smooth interspaces as in typical *Lucina*. *Miltha* has the general shape of *Codakia*, but the sculpture is practically confined to growth lines and all the laterals have become obsolete. In *Anodontia* the cardinals too have become obsolete, as in *Thyasira*, and the shell has become globose and sculptureless. *Divaricella* is in shape and appearance very much like some species of *Myrtea*, except for its divaricate sculpture; but in *eburnea*, at least, its laterals have become obsolete and its cardinals have been modified so that they are more like the cardinals of *Taras*. *Divaricella* is therefore assigned to the *Ungulinidæ*. Both the *Ungulinidæ* and the *Thyasiridæ* are very closely related to the *Codakiidæ* and might better be considered subfamilies, if indeed the *Ungulinidæ* should be separated at all.

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[1] As Blainville'a use of *Phacoides* was vernacular only, the genus must date from Gray, 1847.

[2] *Loripes* J. X. Poli, Test. Sicil., Vol. 1, p. 31 of the introduction, 1791.
Loripes Oken, Lehrbuch Nat., Vol. 3, p. 231, 1815.
? *Loripes* Cuvier, 1817, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 803, 1901, "Type, *Amphidesma lucinalis* Lamarck = *Tellina lactea* of Poli and others, but not of Linnæus, *Lucina leucoma* Turton, *L. amphidesmoides* and *lacteoides* Deshayes and *L. elata* Locard. Habitat, Mediterranean."

Subgenus **MYRTEA** Turton, 1822

Myrtea Turton, Conchylia Insularum Britannicarum, p. 133, 1822; Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 187, 1930.

Myrtæa Turton, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 804, 1901; Woodring, Carnegie Inst. Wash., Publ. No. 366, p. 112, 1925.

Type (by monotypy) *Venus spinifera* Montagu, Test. Brit., p. 577, 1803, Suppl., pl. 17, fig. 1, 1808; Recent, Great Britain.

Section Myrtea, s. s.

Sculpture of closely packed concentric ridges as in *californica* but developed into minute spines posteriorly around the escutcheon.

Section Epilucina Dall, 1901

Epilucina Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 806, 1901.

Type (by original designation), *Lucina californica* Conrad.

This section is very close to *Callucina* Dall (same reference,—type, by original designation, *Lucina radians* Lamarck), which is said to have only one cardinal tooth, the other, presumably, having become obsolete.

Lucina (Myrtea) californica Conrad

Plate 14, Figures 15*a*, 15*b*, 21*a*, 21*b*

Lucina californica Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 255, pl. 20, fig. 1, 1837; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 100, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 247, 1888; Keep, West Coast Shells, p. 178, fig. 151, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 190, 1892; Delos Arnold, Nautilus, Vol. 10, p. 142, 1897; Baker, Nautilus, Vol. 16, p. 43, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 132, 1903.

Phacoides (*Epilucina*) *californicus* Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 813, 1901; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1381, 1903.

Phacoides californica Conrad, E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2, (p. 42), 1919; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 419, 1926.

Callucina californica Dall, U. S. Nat. Mus., Bull. 112, p. 35, 1921.

Phacoides californicus Conrad, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 127, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Pliocene: Cedros Island, Lower California (Jordan and Hertlein); Santa Barbara horizon, upper Pliocene, Bath-house Beach, Santa Barbara (Arnold, 1903).

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro; Pleistocene at Pacific Beach, San Diego (Arnold, 1903); lower San Pedro fauna of Nob Hill, San Pedro, plentiful (T. S. Oldroyd); upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro, rare (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico.

Recent: Crescent City, California, to San Ignacio Lagoon, Lower California, Mexico (Dall, 1921).

This species averages a little smaller and somewhat more ventricose than *acutilineata*. It also lacks the sharp, widely spaced concentric riblets, their place being taken by a multitude of low, closely spaced concentric riblets with occasional growth-line irregularities. The hinge of *californica* has a prominent right anterior cardinal tooth, between which and the beak the elongate, rather deep-set pseudo-lunule projects, fitting into a corresponding space in the left valve anterior to its beak. The anterior and posterior radial plications are obscure or entirely wanting.

Lucina californica Conrad ranges from the upper Pliocene to the Recent in California. It is much less common as a fossil than *L. acutilineata* Conrad.

Lucina (Myrtea) lingualis Carpenter

Lucina lingualis Carpenter, Annals and Magazine of Natural History, Ser. 3, Vol. 13, p. 313, April, 1864; Brit. Assn. Adv. Sci., Rept. for 1863, p. 618, 1864.

Phacoides (Cavilucina) lingualis Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 827, pl. 39, fig. 7, 1901.

Phacoides lingualis Carpenter, Dall, Nautilus, Vol. 32, p. 24, 1918.

Type locality: Cape San Lucas, Lower California, Mexico; Recent.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918).

Recent: Lower California and west coast of Mexico.

Lucina (Myrtea) lampros (Dall)

Phacoides (Cavilucina) lampros Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 827, pl. 39, fig. 9, 1901.

Phacoides lampros Dall, Nautilus, Vol. 32, p. 24, 1918; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Type specimen: In the U. S. National Museum.

Type locality: La Paz, Lower California, Mexico.

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).

Recent: Lower California, Mexico.

L. lampros (Dall) seems to be allied to *L. californica*.

Section LUCINOMA Dall, 1901

Lucinoma Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 806, 1901.

Type (by original designation), *Lucina filosa* Stimpson.

Lucina (Myrtea) acutilineata Conrad

Plate 14, Figures 22*a*, 22*b*

Lucina acutilineata T. A. Conrad, U. S. Expl. Exped. (Wilkes), Vol. 10, Geol., p. 725, October, 1849; Newcombe, Bull. Nat. Hist. Soc. Brit. Columbia, p. 48, 1893; Delos Arnold, Nautilus, Vol. 10, p. 34, 1896, p. 142, 1897; Ralph Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 131, 1903; Dall, in Spurr, 20th Ann. Rept. U. S. Geol. Surv., Pt. 7, p. 264, 1900.

Pectunculus patulus Conrad, *op. cit.*, p. 726, pl. 18, figs. 8, 8*a*, 1849.
Lucina annulata Reeve, Conch. Icon., Vol. 6, *Lucina*, sp. 17, pl. 4, fig. 17, May, 1850.
? *Cyclas permacra* Conrad, U. S. Pacific R. R. Reports, Vol. 7, p. 192, pl. 7, fig. 4, 1857; type specimen No. 13,340, U. S. Nat. Mus.
"*Lucina borealis* Linnæus," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 643, 1864; Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 297, Dec., 1874; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 246, 1888, not of Linnæus.
Cyclas acutilineata Conrad, Amer. Jour. Conch., Vol. 1, p. 153, 1865.
Axinæa patula Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 102, 1868-9.
Phacoides (*Lucinoma*) *annulatus* Reeve, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 813, 1901.
Phacoides annulatus Reeve, Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 594, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, 1915; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, pp. 28, 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916; Nomland, Vol. 10, pp. 212, 220, 301, 303, 1917.
Phacoides (*Lucinoma*) *acutilineata* (Conrad) Dall, U. S. Geol. Surv., Prof. Paper 59, p. 116, 1909.
Phacoides acutilineatus Conrad, Arnold, U. S. Geol. Surv., Bull. 396, p. 122, pl. 8, fig. 4, January 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 30, fig. 4, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 583, 584, 588, 590, 1913; English, Univ. Calif. Publ. Geol., Vol. 8, pp. 210, 213, 1914; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, pp. 28, 32, 1916; Van Winkle, Vol. 1, no. 2, p. 75, 1918; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 306, 1922; Clark, Univ. Calif. Publ. Geol., Vol. 15, p. 89, 1924.
Phacoides annulatus densiliratus Dall, Proc. Biol. Soc. Washington, Vol. 32, p. 249, 1919; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 126, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925.
Lucinoma annulata densilineata Dall, U. S. Nat. Mus., Bull. 112, p. 35, 1921.
Phacoides (*Lucinoma*) *annulata* Reeve, Dall, U. S. Nat. Mus., Bull. 112, p. 35, 1921.
Phacoides columbianum Clark and Arnold, Univ. Calif. Publ. Geol., Vol. 14, pp. 144, 145, pl. 25, figs. 2*a-b*, 1923.
Phacoides (*Lucinoma*) *annulatus* Reeve, Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 126, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: Of *L. acutilineata* Conrad, Astoria, Oregon; Miocene.

Oligocene: Oligocene of Chehalis Valley, Washington (Van Winkle); Sooke formation of Vancouver Island; also Seattle horizon (Oligocene ?) of Washington (Arnold and Hannibal); Oligocene of western Washington (Weaver); etc.

Miocene: Oregon; Martinez; Griswold's, San Benito County; Foxin's, Santa Barbara County (Cooper); Miocene of Washington and Oregon (Conrad; Dall; Weaver; etc.); Miocene of Cape Yaktag, Alaska (Dall, 1900); Vaqueros and Temblor (?) formations, lower and middle Miocene; San Pablo and Santa Margarita formations of middle California; base of Monterey shale in San Luis Obispo County (Nomland, 1910); Bear River Miocene (?) (Martin); Temblor of Stanford University (Arnold, 1903, as Pliocene); etc.

Pliocene Etchegoin, lower Fernando, lower Sargent, Purisima, lower Merced formations of middle California (various authors); lower Fernando of Elsmere Canyon (Arnold, 1907); of Elsmere and Holser canyons (English); S. D. S. N. H. localities 201 and 206, middle (?) and lower Pico of Elsmere Canyon, respectively; localities 215 and 216, lower Pico of Fernando Pass, localities 211, 213, 214, middle Pico of Fernando Pass, Los Angeles County (H. R. G. coll.); San Diego well, middle Pliocene, San Diego (Cooper); Etchegoin of Sargent oil field, San Benito County; middle Wildcat formation of Humboldt County; Merced of Año Nuevo Bay, south of San Francisco (Martin); Pico near Ventura (Waterfall); Santa Barbara horizon, upper Pliocene of Santa Barbara (Arnold, 1903); etc.

Pleistocene: "Pliocene" and lower San Pedro series of Deadman Island and San Pedro, common (Arnold, 1903); lower San Pedro of Nob Hill, San Pedro (T. S. Oldroyd, as var. *densilirata* Dall); Pleistocene of Pacific Beach, San Diego; rare in the upper San Pedro of Deadman Island, Crawfish George's, and San Pedro (Arnold, 1903).

Recent: Alaska to Coronado Islands, Lower California, Mexico (Dall).

This is a lenticular shell with rather regularly disposed, fine, sharp, concentric riblets, and without radial sculpture. The posterior radial sulcus or plication, so pronounced on *L. jamaicensis*, is not well developed, and the anterior one is even less well developed or entirely obsolete. The cardinal teeth are stronger and the lateral teeth much weaker than in *jamaicensis*.

The Oligocene and Miocene specimens are so similar to those of the Pliocene and Quaternary that they are here considered conspecific. The supposed specific differences between the teeth of *annulata* and *acutilineata* is a delusion. "*Phacoides*" *hannibali* Clark is very similar and is certainly closely related.

Section LUCINISCA Dall, 1901

Lucinisca Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 805, 1901.

Type (by original designation), *Lucina nassula* Conrad.

Lucina (Myrtea) nuttallii Conrad

Plate 14, Figures 4*a*, 4*b*, 18

Lucina nuttallii Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 255, pl. 20, fig. 2, 1837; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 100, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 247, 1888; Keep, West Coast Shells, p. 179, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 190, 1892; Delos Arnold, Nautilus, Vol. 10, p. 142, 1897; Ralph Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 132, 1903.

Phacoides (*Lucinisca*) *nuttallii* Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 812, 1901; Trans. Wagner Inst. Sci., Vol. 3, p. 1373, 1903; U. S. Nat. Mus., Bull. 112, p. 35, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 126, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925.

Phacoides nuttallii Conrad, var. *antecedens* Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, pp. 18, 19, pl. 55, fig. 6, 1907.

Phacoides nuttallii Conrad, English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Nomland, Vol. 10, pp. 301, 303, 1917; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 148, 151, 152, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Hanna and Hertlein, Vol. 16, p. 142, 1927.

Miocene: Santa Margarita formation, upper Miocene, north of Coalinga (Nomland).

Pliocene: Lower Fernando of Elsmere and Holser Canyons, Los Angeles County (English); S. D. S. N. H. locality 207, lower Pico of Elsmere Canyon, also 216, lower Pico of Fernando Pass, and 217*a*, middle Pico near Holser Canyon, Los Angeles County (coll. by H. R. G.); Alcatraz asphalt mine, near Sisquoc, Santa Barbara County (Arnold, 1907); Pliocene of Pacific Beach, San Diego (Arnold, 1903); Pliocene of Carmen Island, Mexico (Hanna and Hertlein); Santa Barbara formation at Santa Barbara (Arnold).

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, common; Pleistocene at Pacific Beach and foot of Twenty-sixth St., San Diego (Arnold, 1903); lower Quaternary at Magdalena Bay, Lower California (Jordan, 1924); Tomales Bay, Marin County (Dickerson); upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, Deadman Island, and Long Beach (Arnold, 1903); upper Pleistocene of Scammon Lagoon, San Quintin Bay, and San Ignacio Lagoon, Lower California, Mexico (Jordan, 1924, '26, '27).

Recent: Santa Barbara, California, to Mazatlan, Mexico (1921).

L. nuttallii Conrad is a smaller shell than *californica* or *acutilineata* and is readily recognized by the fine cancellate sculpture. Mature individuals often measure 25 mm. in altitude.

Section PARVILUCINA Dall, 1901

Parvilucina Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 806, 1901.

Type (by original designation), *Lucina tenuisculpta* Carpenter.

The shells of this section are smaller and more convex than those of *Lucinisca*. This section, like some of the others, is hardly of more than specific significance.

Lucina (Myrtea) tenuisculpta Carpenter

Lucina tenuisculpta Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864; Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 297, 1874; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 247, 1888; Baker, Nautilus, Vol. 16, p. 43, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 133, 1903.

Phacoides (*Parvilucina*) *tenuisculptus* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 828, pl. 40, fig. 5, 1901; U. S. Nat. Mus., Bull. 112, p. 35, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 128, pl. 15, fig. 6, pl. 33, figs. 1*a*-*b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925.

Phacoides (*Parvilucina*) *intensus* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1385, pl. 50, fig. 8, 1903.

Phacoides intensus Dall, Arnold, Smithsonian Misc. Coll., Vol. 50, p. 445, pl. 56, figs. 9*a*, 9*b*, Dec. 13, 1907; U. S. Geol. Surv., Bull. 322, pp. 59, 148, pl. 23, figs. 9*a*, 9*b* (same figures), 1907.

Phacoides tenuisculpta Carpenter, Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, 1915.

Shell small, ventricose, with fine radiating riblets and concentric lamellæ. Height, 12 mm.; length, 13 mm.

Type specimens: In the U. S. National Museum; that of *intensa*, No. 135,041.

Type locality: Vancouver Island, British Columbia; Recent.

Miocene: Lower San Pablo formation, lower part of upper Miocene of middle California (Clark).
Pliocene: Middle Pliocene of San Diego well, Balboa Park, San Diego, California (Dall, 1874); Santa Maria district, Santa Barbara Co. (Arnold, 1907).
Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); Pleistocene of Spanish Bight, North Island, San Diego (Arnold, 1903; Mrs. K. Stephens, MS.); rare in the upper San Pedro series of San Pedro (Arnold).
Recent: Nunivak Island, Bering Sea (Dall), to San Martin Island, Lower California (F. Baker).

Codakia (*Jagonia*) *guppyi* Woodring,[1] from the Miocene of Jamaica, appears to be very closely related.

Lucina (**Myrtea**) **tenuisculpta** Carpenter variety **approximata** (Dall)

Plate 14, Figures *8a*, *8b*

Phacoides (*Parvilucina*) *approximatus* Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 813, pl. 39, fig. 4, 1901; U. S. Nat. Mus., Bull. 112, p. 35, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 128, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925.
Parvilucina approximatus Dall, Nautilus, Vol. 32, p. 24, 1918.
Phacoides approximatus Dall, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, no. 7, p. 244, 1926.

Type specimen: In the U. S. National Museum.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, "about 100 valves" (T. S. Oldroyd); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan; Dall, as warm-water Pleistocene); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1926).
Recent: Monterey, California, to Panama (Dall, 1921).

This small, appropriately named form is very close to *L. tenuisculpta* Carpenter, but, according to Dall, is "smaller, more delicate, without the anterior right cardinal tooth which is developed in the northern shell." The radial sculpture of variety *approximata* is more definitely developed than that on typical *tenuisculpta*, it being very faint or obsolete on the latter form. It seems nearer the truth to consider *approximata* a variety or synonym of Carpenter's species.

Lucina (**Myrtea**) **mazatlanica** Carpenter

Lucina mazatlanica Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., pp. 99, 100, 1857; Brit. Assn. Adv. Sci., Rept. for 1856, pp. 248, 307, 1857.
Phacoides (*Here*) *mazatlanicus* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 811, 1901.
Phacoides mazatlanicus Carpenter, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Type locality: Mazatlan, Mexico; Recent.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (E. K. Jordan).
Recent: Gulf of California, Mexico, to Panama.

We have not seen specimens of this species. Dall remarks: "Carpenter's specimens are so small that it is difficult to be certain about them, but they appear to be a distinct species, allied to the Atlantic *P. sombrerensis*. They are distinguished from young *approximatus* by their dense concentric lamellation."

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[1] Carnegie Inst. Wash., Publ. No. 366, p. 110, pl. 14, figs. 5, 6, 7, 1925.

Subgenus **BELLUCINA** Dall, 1901

Bellucina Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 806, 1901.

Type (by original designation), *Lucina pisum* Reeve, 1850 (not Sowerby, 1837, nor d'Orbigny, 1841, nor Philippi, 1850), = *Lucina eucosmia* (Dall), 1901, figured by Reeve, Conch. Icon., Vol. 6, *Lucina*, sp. 66, pl. 11, figs. 66*a-b*, 1850.

"Dorsal areas and sculpture strong." (Dall.)

Dall's arrangement of the *Codakiidæ* appears somewhat mechanical and not entirely satisfactory. *Bellucina* was proposed as a section of the subgenus *Parvilucina;* but as *Parvilucina,* of which *L. tenuisculpta* is the type, is closer to *Myrtea* than is *Bellucina, Parvilucina* is treated as a section of *Myrtea* and *Bellucina* is used as a subgenus.

Lucina (Bellucina) cancellaris Philippi

Lucina cancellaris R. A. Philippi, Zeitschr. f. Malakozool., p. 21, Feb., 1846.
Phacoides (*Bellucina*) *cancellaris* Philippi, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 814, pl. 39, fig. 11, 1901.
Phacoides cancellaris Philippi, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Cedros Island, west of Lower California, south to the Gulf of California and to Panama, in 5 to 30 fathoms (Dall, 1901).

As figured by Dall, this species has about eleven broad ribs with concentric cancellations.

Subgenus **HERE** Gabb, 1866

Here Gabb, Geological Survey of California, Palæontology, Vol. 2, sect. 1, part 1, p. 28, 1866; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 251, 1871, "Type, *Luc.* (*Here*) *Richthofeni*, Gabb"; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 805, 1901.

Type (virtually by monotypy; designated by Stoliczka, 1871), *Lucina* (*Here*) *richthofeni* Gabb.

"Shell having all of the usual characters of *Lucina*, except that the lunule is very deeply excavated, penetrating the hinge plate, and almost perforating it; bounded anteriorly by the anterior lateral tooth, and posteriorly by the cardinal tooth." (Gabb.)

Lucina (Here) excavata Carpenter

Plate 14, Figures 2, 5, 10

Lucina excavata Carpenter, Cat. Reigan Coll. Mazatlan Moll. Brit. Mus., p. 98, 1857.
Lucina (*Here*) *richthofeni* Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 29, 1866.
Phacoides (*Here*) *richthofeni* Gabb, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 810, pl. 40, figs. 7, 9, 1901; U. S. Nat. Mus., Bull. 112, p. 35, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 126, 1924.
Phacoides richthofeni Gabb, Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 543, pl. 45, fig. 4, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Clark, Vol. 8, p. 419, 1915; Nomland, Vol. 10, pp. 220, 310, 1917; Wagner and Schilling, Vol. 14, pp. 243, 244, 1923; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.
Lucina (*Here*) *excavata* Carpenter, Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 181, pl. 15, fig. 3, pl. 17, fig. 5, 1930.

Type localities: Of *richthofeni*, San Fernando Valley, Los Angeles County, Pliocene; of *excavata*, Mazatlan, Mexico, Recent.

Oligocene: San Emigdio region (Wagner and Schilling).
Miocene: Lower Miocene three miles south of Calabasas, Los Angeles County (Arnold, 1907); Santa Margarita formation, upper Miocene, of the Tejon Hills (Nomland); San Pablo formation of middle California (Clark).

Pliocene: Lower Fernando of Elsmere and Holser canyons, Los Angeles County (English); common at various lower and middle Pico localities in Elsmere Canyon and the San Fernando Pass region, Los Angeles County (coll. by H. R. G.); Pliocene of San Fernando Valley (Gabb); rare in the *Chione elsmerensis* zone of the Etchegoin formation (Nomland).

Pleistocene: Lower Quaternary at Magdalena Bay, and upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan).

Recent: San Pedro, California, to Mazatlan, Mexico.

Lucina excavata Carpenter is readily recognized by its globose, inflated shape, concentric ridges, and deeply depressed pseudo-lunule. With the two valves together, as they often are, even in fossils, it resembles a nut.

Subgenus **MILTHA** H. and A. Adams, 1857

Miltha H. and A. Adams, Genera of Recent Mollusca, Vol. 2, p. 468, April, 1857, only species, *Lucina* (*Miltha*) *childreni* Gray; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 806, 1901; Trans. Wagner Free Inst. Sci., Vol. 3, p. 1361, 1903.

Milthea H. and A. Adams, Meek, Report of the U. S. Geological Survey of the Territories, Vol. 9, p. 131, 1876.

Type (by monotypy), *Lucina* (*Miltha*) *childrenæ* Gray, 1825, Recent, from Brazil (see below).

"Shell inequivalve, with the surface of the valves nearly smooth. Hinge with the lateral teeth obsolete." (H. and A. Adams.)

The type of this subgenus was long supposed to have come from the Pacific coast,[1] but Dall has stated that its habitat is Brazil.

Lucina (Miltha) xantusi (Dall)

Plate 14, Figures 20*a*, 20*b*

"*Lucina childreni* Gray," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 552, 620, 1864, (? not *Lucina childrenæ* J. E. Gray, Annals of Philosophy, Vol. 25, p. 136, February, 1825; nor *Lucina* "*childreni*" Gray, G. B. Sowerby, 2nd, Genera of Shells, Pt. 27, 1827, nor "*Tellina*" *childreni* Gray, Wood, Index Testaceologicus, Supplement, Plate 1, fig. 1, 1828); also of Pacific coast conchologists prior to 1905.

"*Phacoides* (*Miltha*) *childreni* Gray," Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 812, 1901; Trans. Wagner Inst. Sci., Vol. 3, p. 1377, 1903.

Phacoides (*Miltha*) *xantusi* Dall, Nautilus, Vol. 18, p. 111, Feb., 1905; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, pp. 474, 475, pl. 28, fig. 7, pl. 29, fig. 1, 1926.

? *Phacoides joannis* Dall, Nautilus, Vol. 18, p. 112, 1905 (original description ?).

Phacoides (*Miltha*) *sanctæcrucis* Arnold, U. S. Geol. Surv., Bull. 396, pp. 17, 57, pl. 6, fig. 6, January 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 28, fig. 6, 1910.

Phacoides "*santæcrucis*" Arnold, English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914.

Phacoides "*santæcrusis*" Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 301, 1917.

Type localities: Of *L. childrenæ* Gray, Brazil (?); of *P. xantusi* Dall, Lower California; of *P. sanctæcrucis* Arnold, in "reef bed" one-fourth of a mile southeast of Barton's Cabin, Devil's Den district, Kern County, Temblor formation, middle Miocene, *Turritella ocoyana* zone (lower Miocene of Arnold, 1910).

Miocene: Temblor formation of Devil's Den district, Kern County; Miocene of Mindego Creek, Santa Cruz Mountains, San Mateo County; in many of the "lower" [middle ?] Miocene faunas of the Coast Ranges (Arnold, 1910); Santa Margarita formation, upper Miocene, of the Tejon Hills and also north of Coalinga (Nomland).

Pliocene: Lower Fernando of Elsmere and Holser Canyons, Los Angeles County (English); S. D. S. N. H. localities 201, 203, 207, and 210, lower Pico of Elsmere Canyon, Los Angeles County (coll. by H. R. G.); Etchegoin of Coalinga region (Nomland); S. D. S. N. H. localities 211, 213, and 214, middle Pico west of Fernando Pass, and locality 217, middle Pico near Holser Canyon, Los Angeles County (coll. by H. R. G.); Pliocene of San Juan, Gulf of California (Dall, 1903); Pliocene of Coyote Mountain, western Imperial County, California (Hanna).

Recent: Gulf of California, Cape San Lucas, Lower California; Mazatlan, Mexico (Dall, 1901).

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[1] Carpenter, Brit. Ass. Adv. Sci., Rept. for 1863, p. 522, 1864, says of this species: "There is no authority for the statement that it comes from Brazil. The Br. Mus. specimens are from 'Mus. Cracherode', and are probably west coast. The only known locality is Cape St. Lucas."

This is a moderately large, flattened species, showing the growth lines clearly. Some specimens show an inward bending of the growth lines occurring in a radial band from the umbonal region to the ventral margin of the valve, but this character seems to occur sporadically and cannot be used for specific or varietal differentiation.

Lucina (Miltha?) jacalitosana (Arnold)

Paphia jacalitosana Arnold, U. S. Geol. Surv., Bull. 396, p. 66, pl. 16, fig. 3, January 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 38, fig. 3, 1910.

Type specimen: U. S. National Museum, Cat. No. 165,587.

Type locality: On Ramirez place at forks of Jacalitos Creek a short distance northeast of Reef Ridge, Coalinga district, California; Jacalitos formation, lower Pliocene.

Pliocene: Lower Pliocene at type locality.

So far as the writers know, this species has not been recognized by paleontologists since its original description. It may be a synonym of *Lucina* (*Miltha*) *xantusi* (Dall).

Genus ANODONTIA Link, 1807

Anodontia Link, Beschr. Rostock Samml., p. 56, 1807, sole example, *Venus edentula* Gmelin, *fide* Dall, Trans. Wagner Inst. Sci., Vol. 7, p. 1352, 1903.
Lucina (Bruguière) Lamarck, of Dall, Proc. U. S. Nat. Mus., Vol. 23, pp. 801, 802, 1901.
Pegophysema Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 185, 1930.

Type (by subsequent designation, Dall, 1901), *Venus edentula* Linnæus.

"Shell inflated, thin, concentrically striated, anterior and posterior dorsal areas obsolete; lunule deep and narrow, no visible escutcheon; ligament and resilium deeply inset, but not occluded; margins entire, anterior adductor scar long, hinge wholly edentulous, shell usually large." (Dall.)

This genus is related to *Lucina* as *Serripes* is to *Lævicardium*.

Anodontia edentuloides (Verrill)

Loripes edentuloides Verrill, Amer. Jour. Sci., Ser. 2, Vol. 49 (Whole No. 99), p. 226, 1870.
Lucina edentuloides Verrill, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 802, 1901; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 466, 1926.

Type specimen: In the Museum of Yale University.

Type locality: La Paz, Lower California, Mexico; Recent.

Pliocene: Imperial formation, Coyote Mountain, western Imperial County (Hanna).
Recent: Magdalena Bay, Lower California, south and into the Gulf of California (Dall).

This species is closely allied to the Caribbean shell which Reeve identified as *L. edentula* (not the *edentula* of Linnæus, *fide* Dall, 1901). It was described by Verrill as being "subglobose, and much more swollen than *L. edentula*. The apex is more prominent and curved, and the lunular region more deeply excavated. The ligament is shorter and its supporting plate is not so stout, and its inner edge but little elevated above the ligament groove."

Family UNGULINIDAE

Shell subcircular in outline, or irregular if nestling in habit; cardinal teeth small, normal; laterals obscure or absent; valve margins plain; pallial line entire.

It is probable that this family should be included in the *Codakiidæ*.

Genus TARAS Risso, 1826

Taras Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 344, 1826; Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 193, 1930.

Mysia Leach, Brown, Ill. Conch. Gt. Brit., Ed. 1, pl. 16, fig. 11, 1827; Ed. 2, p. 98, 1844; Gray, Syn. Cont. Brit. Mus., Ed. 42, p. 150, 1840; Ann. Mag. Nat. Hist., Vol. 20, p. 272, 1847; Cossmann, Soc. Roy. Malac. Belgique, Vol. 22, p. 17, 1887; not *Mysia* Leach in Lamarck, Hist. Nat. Anim. s. Vert., Vol. 5, p. 543, 1818; Desh. and M. Edw. Ed., Vol. 6, p. 229, 1835; Gray, Proc. Zool. Soc. London, p. 195, 1847; type (by monotypy) *Venus undata* Pennant, referred by Dall to the *Veneridæ*.

Diplodonta H. G. Bronn, Ergebnisse meiner naturhistorisch-ökonomischen Reisen, Vol. 2, p. 484, 1831; Italiens Tertiär-Gebilde und deren organische Einschlüsse, pp. ix-xii, 1831; Herrmannsen, Indicis Generum Malacozoorum, Primordia, Vol. 1, p. 392, 1847, type designated, *Venus lupinus* Brocchi, Conch. Subappen., Vol. 2, p. 553, pl. 14, fig. 8, 1814, = *? Tellina rotundata* Montagu, Pliocene of England and Italy, Recent; Dall, Jour. Conch., Vol. 9, no. 8, p. 244, Oct., 1899; Proc. U. S. Nat. Mus., Vol. 23, p. 791, 1901; Dall, in Zittel-Eastman, Textbook of Paleo., Ed. 2, Revised, p. 487, 1913; Woodring, Carnegie Inst. Wash., Publ. No. 366, p. 128, 1925.

Type (by monotypy), *Taras antiquatus* Risso, *op. cit.*, p. 344, fig. 167, 1826, Pliocene or Pleistocene of Trinité (Riviera), related to *rotundatus* (Montagu), *fide* Stewart.

Thin-shelled, orbicular, convex, concentrically striate or pustulose; cardinals 2:2, the left anterior and right posterior bifid; laterals obscure or absent. (Dall, in Zittel-Eastman, 1913.)

Geologic range: Eocene to Recent.

Section TARAS, s. s.

Shell with growth lines only, rather ventricose, valves slightly inequilateral.

Taras orbellus (Gould)

Plate 14, Figures 14*a*, 14*b*

Lucina orbella Gould, Proc. Boston. Soc. Nat. Hist., Vol. 4, p. 90, 1852; Boston Jour. Nat. Hist., Vol. 6, pp. 395, 396, pl. 15, fig. 3, 1853.

Diplodonta orbella Gould, Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 238, 1888; Dall, Jour. Conchology, Vol. 9, no. 8, p. 245, 1899; Trans. Wagner Inst. Sci., Vol. 3, p. 1189, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 795, 1901; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 134, pl. 18, figs. 8, 8*a*, 1903; Lamy, Jour. de Conchyl., Vol. 57, p. 238, 1909; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 418, 1915; Dall, Nautilus, Vol. 32, p. 24, 1918; U. S. Nat. Mus., Bull. 112, p. 34, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 124, pl. 6, figs. 5, 6, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925.

Type locality: San Diego, California; Recent.

Miocene: Upper San Pablo of middle California (Clark, 1915).

Pliocene: Etchegoin of middle California (Clark, 1915; etc.); San Diego well, Balboa Park, San Diego (Dall).

Pleistocene: Lower San Pedro series of Deadman Island, San Pedro Harbor, rare (Arnold, 1903); lower San Pedro series of Nob Hill cut (T. S. Oldroyd); lower Quaternary at Magdalena Bay, Lower California, Mexico (E. K. Jordan); foot of Twenty-sixth St., San Diego; upper San Pedro series at San Pedro and Crawfish George's (Arnold); warm-water Pleistocene fauna at Magdalena Bay, Lower California, Mexico (Dall, 1918); upper San Pedro formation at Santa Monica (Oldroyd Collection).

Recent: Pribilof Islands, Bering Sea, to Gulf of California (Dall).

This is a rather small, subglobose shell with median, inconspicuous beaks and fine growth lines. *T. harfordi* (F. M. Anderson) and *T. buwaldanus* (Anderson and Martin) are very similar.

Taras harfordi (F. M. Anderson)

Diplodonta harfordi Anderson, Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 197, pl. 17, figs. 88, 89, 1905; Arnold, U. S. Geol. Surv., Bull. 396, pp. 25, 140, pl. 17, fig. 6, Jan. 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 39, fig. 6, 1910; Woodford, Univ. Calif. Publ. Geol., Vol. 15, p. 208, 1925.

Miocene: Temblor formation, lower middle Miocene, sea cliff one-quarter mile northwest of Laguna Canyon, Orange County, California (Woodford); Santa Margarita formation west of Coalinga (Coalinga Beds, type locality, F. M. Anderson).

Pliocene: Questionably in the Jacalitos beds, lower part of the Etchegoin formation, lower Pliocene (Arnold, 1910); Etchegoin of Coalinga region (Arnold and F. M. Anderson).

This species appears to be very closely related to *orbellus*, but can be distinguished by its more projecting, less twisted beaks, and by the fact that *orbellus* is usually more inflated, especially in the northern variety *aleuticus* (Dall). Arnold's figured specimen looks more like *parilis* or *sericatus*.

Taras buwaldanus (Anderson and Martin)

Diplodonta buwaldana Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 56, pl. 3, figs. 1*a*, 1*b*, 1914.

Type locality: Middle portion of the lower Miocene, near Barker's Ranch, Kern River.

This form is small, round, smooth, inflated, practically indistinguishable from *orbellus*, but the dorsal margin is more convex behind the beaks. *T. harfordi* is less convex and has more prominent, straighter beaks, showing a slightly closer relationship with *parilis* (+ *sericatus*).

Section FELANIELLA Dall, 1899

Felaniella Dall, Journ. Conch., Vol. 9, no. 8, p. 244, October, 1899.

Type (by original designation), *Felania usta* Gould.

"Shell like *Diplodonta*, but heavy, compressed, externally smooth, with a conspicuous dark periostracum and less equilateral valves." (Dall.)

This section is probably of little value.

Dall has placed the species with the punctate or pustulate surface (type *D. semirugosa* Dall, + *D. semiaspera* Carpenter, Mazat. Cat., p. 102, 1857, not of Philippi, 1836) in the section *Phlyctiderma* Dall, *op. cit.*, p. 246.

Taras parilis (Conrad)

Loripes parilis Conrad, Amer. Jour. Sci., Ser. 2, Vol. 5, p. 432, fig. 7, 1848.

Mysia parilis Conrad, Amer. Jour. Conch., Vol. 1, p. 153, 1865; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 100, 1868-9.

Diplodonta parilis Conrad, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1182, 1900; Arnold, U. S. Geol. Surv., Bull. 396, p. 140, pl. 17, fig. 5, 1910; Arnold and R. Anderson, Bull. 398, p. 108, pl. 39, fig. 5, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 588, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 418, 1915; Nomland, Vol. 10, p. 219, 1917.

Miocene: Empire formation of Oregon (Dall; Arnold and Hannibal; Howe; etc.); Montesano formation (Weaver); San Pablo formation (Clark).

Pliocene: Etchegoin formation (Arnold); *Chione elsmerensis* zone and *Pecten coalingensis* zone of Etchegoin formation of Coalinga region (Nomland)

Pleistocene and *Recent:* As *T. sericatus* (Reeve).

This species resembles the form *sericatus* (Reeve) so closely that the latter should be considered conspecific.

Taras parilis (Conrad) variety **sericatus** (Reeve)

Plate 14, Figures 12*a*, 12*b*

Lucina sericata Reeve, Conch. Icon., Vol. 6, *Lucina*, sp. 55, pl. 9, fig. 55, June, 1850.
Diplodonta serricata Reeve, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 248, 1857; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 134, pl. 18, figs. 5, 5*a*, 1903.
Felaniella sericata Reeve, Dall, U. S. Nat. Mus., Bull. 112, p. 34, 1921.
Diplodonta sericata Reeve, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 125, 1924.

Pleistocene: Foot of Twenty-sixth Street, San Diego, common (Arnold; Mrs. K. Stephens MS.); upper San Pedro series of San Pedro (Arnold).
Recent: San Diego, California, to Panama.

This form is probably inseparable from the Pliocene form of *Taras parilis* (Conrad), but we retain it as a variety until larger suites of specimens are available for study. *Lucina cornea* Reeve and *Lucina nitens* Reeve (*op. cit.* species 25, 50) are probably of the same species.

Genus DIVARICELLA von Martens, 1880

Lucina sp. of many authors before 1880.
"*Cyclas* Klein," Mörch, Cat. Yoldi, Pt. 2, p. 32, *C. quadrisulcata* d'Orbigny + *T. divaricata* Chemnitz included, 1853; not *Cyclas* Lamarck, Ency. Méth., Tabl. Vers, pl. 301, 1798; Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 84, 1799.
Divaricella von Martens, in Moebius' Beiträge zur Meeresfauna der Insel Mauritius und der Seychellen, Mollusken, p. 321, 1880, only species *L. angulifera* von Martens, pl. 22, fig. 14, = *Lucina ornata* Reeve, 1850, not of C. B. Adams, 1852, *fide* Dall, 1903; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1387, 1903.
Lucinella Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 18, 1884.

Type (by monotypy), *Lucina angulifera* von Martens, *op. cit.*, pl. 22, fig. 14, 1880, = *Lucina ornata* Reeve, Conch. Icon., Vol. 6, *Lucina*, pl. 8, fig. 48, 1850; Mauritius, Recent.

Shell much like that of *Taras*, but with divaricate sculpture, a more polished surface, and lower convexity.

Geologic range: Eocene to Recent.

The differences between *Myrtea* and *Divaricella* might not be of more than subgeneric importance, for species of the latter group closely approach species of *Myrtea*, except in sculpture. *Divaricella* generally does not have external anterior and posterior ridges, the pseudo-lunule is very small and deeply impressed, larger in the right valve than in the left, and the lateral teeth are small. However, *Divaricella* seems to be even more like *Taras*. The divaricate sculpture is so conspicuous that the custom has been to consider it a distinctive generic character.

Lucinella Monterosato differs from *Divaricella, s. s.*, according to Dall, in that the ligament is obsolete, and the resilium is wholly internal, as in *Semele*. It was considered a synonym of *Divaricella* by Bucquoy, Dautzenberg, and Dollfus.

Divaricella dentata (Wood)

Tellina dentata Wood, General Conch., p. 195, pl. 46, fig. 7, 1815; Dillwyn, Descr. Cat. Rec. Sh., Vol. 1, p. 103, 1817; Tryon, Proc. Acad. Nat. Sci. Phila. for 1872, p. 85, 1872; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1390, 1903; not *Lucina dentata* Defrance, Dict. Sci. Nat., Vol. 27, p. 275, 1823; nor *L. dentata* Basterot, Mém. Soc. Hist. Nat. Paris, Vol. 2, p. 87, 1827.
"*Lucina divaricata* Linnæus," Lamarck, 1818, and others, not *Tellina divaricata* Linnæus.
Lucina serrata d'Orbigny, Voy. Amer. Mérid., Vol. 5, Pt. 3, p. 384, 1840; in R. de la Sagra, Hist. Phys. Polit. Nat. Cuba, Vol. 2, p. 295, pl. 27, figs. 37, 39, 1853.
? *Lucina ornatissima* d'Orbigny, *op. cit.*, p. 384, 1840, *fide* Tryon.
? *Lucina chemnitzii* Philippi, Zeitschr. f. Malakozool., Vol. 4, p. 151, March ?, 1849.
? *Lucina ornata* Reeve, Conch. Icon., Vol. 6, *Lucina*, pl. 8, fig. 48, 1850.

Shell of medium size, suborbicular; margin of valves circular in outline except for the dorsal portion, which is less curved, margin somewhat serrated, especially on the dorsal portions of old individuals; umbones central, rather small, beaks slightly inclined forward; surface of valves with divaricate sculpture; hinge teeth small, posterior lateral elongate, distant, anterior cardinal distant, assuming position of a lateral. Dimensions of mature specimens: Length 20 to 28 mm.; height, 19 to 26 mm.; convexity of both (matched) valves, 12 to 15 mm.

Variety **dentata**, s. s.

Hinge teeth very weak, posterior lateral absent or reduced to a slight, distant protrusion, extending downward, not outward.

Pleistocene: Santo Domingo (Gabb, *fide* Dall).
Recent: Cape Hatteras, North Carolina, to Brazil (Dall).

Divaricella dentata (Wood) has a very much involved early synonymy. Unfortunately, Wood did not assign any habitat to his well-figured species, but the American Atlantic coast shell is so similar to Wood's picture that it is probable that later authors have correctly identified it. In his Catalogue of the *Lucinidæ* Tryon[1] included a number of names, most of which are probably closely related to *dentata*, if not exact synonyms; but a few, such as *L. eburnea* Reeve and *L. quadrisulcata* d'Orbigny,[2] appear to be varietally or specifically distinct. *D. quadrisulcata* (d'Orbigny), according to Dall, can be distinguished by its "extremely small, deep, cordate lunule" and "frequently by its greater size and solidity." Its range is given as Miocene to Recent. *D. eburnea* (Reeve) was described from Recent specimens from Mazatlan. It appears to be only varietally distinct from the Florida *dentata*.

Divaricella dentata (Wood) variety **eburnea** (Reeve)

Plate 14, Figures 1*a*, 1*b*

Lucina eburnea Reeve, Conch. Icon., Vol. 6, pl. 8, fig. 49, June, 1850; not *Lucina eburnea* Deshayes, Bull. Soc. Géol. France, Vol. 6, p. 321, 1835, *nomen nudum.*

Divaricella eburnea Reeve, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 815, 1901; Nautilus, Vol. 23, p. 24, 1918; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 464, pl. 26, figs. 8, 9, 1926; Hanna and Hertlein, Vol. 16, p. 140, 1927.

Divaricata eburnea Reeve, Kew, Univ. Calif. Publ. Geol., Vol. 8, p. 46, 1914.

Divaricella lucasana Dall and Ochsner, Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 122, pl. 2, figs. 17, 21, 24, 1930, new name for *eburnea* Reeve.

Shell like that of the typical variety of *dentata*, but with the hinge teeth stronger, the posterior lateral tooth projecting outward from the hinge.

Type locality: Mazatlan, Mexico; Recent.

Pliocene: Coyote Mountain, lower division (Kew); Imperial formation of Coyote Mountain (Hanna); Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Pleistocene: Magdalena Bay, Lower California, Mexico (Dall); Oaxaca, Mexico (coll. by R. H. Palmer); Albemarle Island, Galapagos Group (Dall and Ochsner).
Recent: Cape St. Lucas, Lower California, Mexico, to Panama (Dall, 1901); ? Caribbean.

The comparison of a series of specimens of *dentata* from Florida localities with numerous specimens from west Mexican waters shows that the only significant difference between the two forms is in the hinge teeth. The Atlantic form, which we have assumed to be the typical variety, has either a very small posterior lateral tooth projecting downward toward the ventral margin, or none at all. This difference between the two varieties is small but in all the specimens examined it is constant.

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[1] Catalogue and Synonymy of the Recent Species of the Family *Lucinidæ*, Proc. Acad. Nat. Sci. Phila. for 1872, pp. 82-96; see page 85.

[2] Voy. Amer. Mérid., Vol. 5, Pt. 3, p. 584, 1846; in R. de la Sagra, Hist. Phys. Polit. Nat. Cuba, Moll., Vol. 2, p. 294, pl. 27, figs. 34, 36, 1853; also figured by Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1389, pl. 51, fig. 1, 1903. For dates of publication of the natural history parts of d'Orbigny's Voy. Amer. Mérid., see Sherborn and Woodward, Ann. Mag. Nat. Hist., Ser. 7, Vol. 7. pp. 388-390, 1901.

It should be noted that the strength of the serrations on the margins of the valves of *dentata*, both on the typical *dentata* and on the variety *eburnea*, is a function of the age of the individual. Large shells, representing mature individuals, are conspicuously serrate, especially on the dorsal margins, whereas small, young shells may have almost smooth margins. The serrations tend to be most prominent on the posterior dorsal margins.

Since Deshayes' use of the name *eburnea* in 1835 is merely as a *nomen nudum* in a list, it does not invalidate Reeve's name; and unless some other use before 1850 is found, *lucasana* is unnecessary. The name *quadrisulcata* noted above in the discussion of the genus may be an early, valid name for *eburnea*, in which case the latter will be discarded anyway. E. A. Smith[1] stated that he was not able to find any valid distinction between specimens of *eburnea* (Reeve) from St. Elena, West Colombia, and Panama and *quadrisulcata* (d'Orbigny). It would not be surprising to have this variety in the Caribbean also.

Divaricella dentata (Wood) variety **perparvula** Dall

Lucina pisum Philippi, Abbild. Besch. Conch., Vol. 3, p. 105, pl. 2, fig. 9, April, 1850; not *L. pisum* Sowerby, 1837, nor *L. pisum* d'Orbigny, 1841, *fide* Dall, nor *L. pisum* Reeve, November, 1850.

Divaricella perparvula Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 815, pl. 39, fig. 8, August 22, 1901; Bull. 112, U. S. Nat. Mus., p. 36, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Shell small, globular, with rather sparse sculpture, more tumid than the young of *eburnea*. Length and height each about 7 mm. (After Dall.)

Type specimen: Of *perparvula* Dall, in U. S. National Museum.

Type locality: Of *L. pisum* Philippi, Mazaltan, Mexico; Recent.

Pleistocene: Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Cape San Lucas to Ecuador (Dall, 1921).

The size of this shell suggests that it might be the young of *dentata* variety *eburnea* (or *quadrisulcata*), but the figures given by Philippi and by Dall show less flattening of the profile of the dorsal margin. Authentic specimens have not been available. Tentatively, we have considered it a small variety of *dentata*. The sparseness of the divaricating grooves is due, at least partly, to the magnification of the illustrations of this variety.

Superfamily SPHAERIACEA

Shells specialized for fresh or brackish water conditions.

Family SPHAERIIDAE

Hinge with cardinal teeth variable, sometimes prominent and bifid at the summit, three in each valve, or hinge plate not definitely thickened, cardinals widely divergent or thin and nearly parallel to hinge margin; lateral teeth separated from the cardinals, anterior and posterior double in the right valve, single in the left.

Geologic range: Triassic to Recent.

The shells of this family are variable in shape and in the character of the hinge. It might have seemed desirable to separate the species having definite diverging cardinal teeth from those which have an unthickened hinge plate and cardinal teeth which are obscure or very thin and parallel to the hinge margin, but the type of *Sphærium* Scopoli, as figured by Forbes and Hanley, scarcely permits placing *Sphærium* and *Corbicula* in different Families.

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[1] Challenger Repts., Zool., Vol. 13, Pt. 1, p. 178, 1885.

Genus CORBICULA Megerle von Mühlfeld, 1811

Corbicula J. K. Megerle von Mühlfeld, Gesellschaft Naturforschender Freunde zu Berlin, Magazin, Jahrgang 5, pt. 1, p. 56, 1811, includes *Corbicula fluminalis;* Gray, Proc. Zool. Soc. London, Pt. 15, p. 184, 1847.

Cyrena Lamarck, Hist. Nat. Anim. s. Vert., Vol. 5, p. 551, 1818; includes *C. cor* Lamarck and others; Children, Quart. Jour. Sci., Lit., Arts, Vol. 14, p. 311, January, 1823, type cited, "*Cyrena cor* Lamarck," figured pl. 6, fig. 53.

Type (by subsequent designation, Gray, 1847), *Corbicula fluminalis* Megerle, = *Tellina fluminalis* Müller, Vermium Terrest., Vol. 2, p. 205, 1774 + *Cyrena cor* Lamarck.

Shell rounded-trigonal, ventricose, concentrically sculptured, with smooth margins; cardinals three, laterals smooth or cross-striated.

Geologic range: Cretaceous to Recent.

Corbicula gabbiana (Henderson)

Cyrena california Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 26, pl. 7, fig. 45, 1866, p. 98, 1868-9; Cooper, 7th Ann. Report Calif. State Mineralogist, p. 238, 1888; not *Cyrena californica* Prime, 1865.

Corbicula californica Gabb, Clark, Univ. Calif. Publ. Geol., Vol. 7, p. 57, 1912.

Cyrena (*Corbicula*) *californica* Gabb, Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 418, 459, pl. 56, fig. 2, 1915.

Corbicula gabbiana Junius Henderson, Nautilus, Vol. 33, p. 120, April 1920, new name for *C. californica* Gabb, 1866, not *Cyrena californica* Prime, 1865.

Type locality: Kirker's Pass, Contra Costa County, California, upper Miocene (Gabb, as "Pliocene").

Miocene: Upper part of San Pablo formation, upper Miocene, at Kirker's, and along San Pablo Bay, Contra Costa County (Clark, 1915).

Pliocene: Jacalitos formation, lower Pliocene (Clark).

This species is quite variable in shape. Generally the umbones are quite prominent. We have not seen the hinge.

Corbicula kettlemanensis (Arnold)

Sphærium kettlemanensis Arnold, U. S. Geol. Surv., Bull. 396, p. 94, pl. 30, figs. 1, 1*a*, January 15, 1910; Arnold and Anderson, Bull. 398, pl. 52, figs. 1, 1*a*, 1910; Hannibal, Proc. Malac. Soc. London, Vol. 10, p. 131, 1912.

Type specimen: U. S. National Museum, No. 165,519.

Type locality: Near Kettleman Hills, Coalinga district, California; Pleistocene.

Pleistocene: Base of the Tulare formation, near Kettleman Hills, Coalinga district, California, fresh water, lower Pleistocene (Arnold, as "Pliocene").

Arnold's figure of this species shows it to have cardinal teeth more like *Corbicula* than *Sphærium.* Hannibal synonymized this species along with *S. cooperi* Arnold under "*Spharium* (*Amesoda*) *simile* Say." *S. cooperi* Arnold is quite different.

Genus SPHAERIUM Scopoli, 1777

Sphærium Scopoli; Introductio ad Historiam Naturalem, pp. 397, 398, 1777, only species *Tellina cornea;* placed on the official list of Generic Names by Opinion 94 of the Int. Comm. Zool. Nomen., Smiths. Misc. coll., Vol. 73, p. 13, 1926.

Cyclas Lamarck, Ency. Méth., pls. 301, 302, 1798, *fide* Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 196, 1930.

Type (by monotypy), "*Tellina cornea*" Linnæus, Syst. Nat., Ed. 10, p. 678, 1758; figured by Forbes and Hanley, Hist. Brit. Moll., Vol. 2, p. 113, pl. 37, figs. 3-6, 1853.

Shell with a scarcely thickened hinge plate; weak cardinal teeth, widely diverging and in extreme cases very thin and parallel to the hinge margin.

Distribution: In fresh and brackish water.

Sphaerium cooperi Arnold

Sphærium cooperi Arnold, U. S. Geol. Surv., Bull. 396, p. 94, pl. 30, figs. 2, *2a*, January 15, 1910; Arnold and R. Anderson, Bull. 398, pl. 52, figs. 2, *2a*, 1910; Hannibal, Proc. Malac. Soc. London, Vol. 10, p. 131, 1912.

Type specimen: U. S. National Museum, No. 165,528.

Type locality: Near Kettleman Hills, Coalinga district, California; base of the Tulare formation, fresh-water Pleistocene.

Pleistocene: At the type locality, lower Pleistocene.

The cardinal teeth of this species are very thin, elongate, and approximately parallel to the hinge margin.

Superfamily Erycinacea

Family ERYCINIDAE

Genus ERYCINA Lamarck, 1805

Erycina Lamarck, Ann. Mus. Hist. Nat. Paris, Vol. 6, p. 413, December, 1805, list includes *E. pellucida* but not *E. cardioides;* Froriep, Neues Syst. Conch., p. 38, 1807; Children, Quart. Jour. Sci., Lit., Arts, Vol. 14, p. 299, 1823, "type" *E. cardioides* Lamarck; Stoliezka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 263, 1871, type, *E. pellucida*, Lam.; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1140, 1141, 1900.

Type (by subsequent designation, Stoliczka, 1871), *Erycina pellucida* Lamarck, *op. cit.*, p. 414, 1805, figured by Cossmann and Pissarro, Icon. Coq. Fos. Eoc. Env. Paris, pl. 27, fig. 88-1, 1906, Eocene of the Paris basin.

Shell small, smooth, or concentrically sculptured; hinge with small cardinal teeth, laterals long, stronger distally; resilium in a fosette between the cardinal teeth.

This genus occurs in the Eocene of Europe and is represented in the Recent fauna of the Pacific coast. It has not yet been reported from the Pliocene or Pleistocene of California, but can be expected to occur there.

We use the family name *Erycinidæ*, based upon the oldest described genus, in place of *Leptonidæ*.

Genus CHIRONIA Deshayes, 1839

Chironia Deshayes, Rev. Zool. Soc. Cuv., p. 356, 1839; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 264, 1871; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1153, 1900, in synonymy of *Kellia.*

"*Kellia* Turton," Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1153, 1900; and of various other authors.

Type (*fide* Dall, 1900), *C. laperousii* Deshayes.

Shell ovate, subglobose; hinge with two cardinals in each valve, a large posterior and a small anterior right cardinal, and a small posterior and a large anterior left cardinal; a posterior but no anterior lateral; pallial line entire. Size generally small, length varying up to about 40 mm.

Chironia suborbicularis (Montagu)

Mya suborbicularis Montagu, Test. Brit., pp. 39, 564, 1803.

Tellina suborbicularis Montagu, Turton, Conch. Dict., p. 179, 1819.

Kellia suborbicularis Montagu, Turton, Conchyl. Insul. Brit., Dithyra, p. 56, pl. 11, figs. 5, 6, 1822; Forbes and Hanley, Hist. Brit. Moll., Vol. 2, p. 87, pl. 18, figs. 9, *9a*, *9b*, and pl. O, fig. 4, 1853.

Tellimya suborbicularis Montagu, Brown, Illust. Conch. Gt. Brit., Ed. 2, p. 106, pl. 42, figs. 14, 15, 1844.

Type locality: England; Recent.

The English variety averages a little smaller than the Pacific coast variety, but the two forms are very similar. The former is well figured by Forbes and Hanley.

Chironia suborbicularis (Montagu) variety **laperousii** Deshayes

Plate 14, Figures 19*a*, 19*b*

Chironia laperousii Deshayes, Rev. Zool. Soc. Cuvierienne, Vol. 2, p. 357, 1839.

"*Kellia suborbicularis* Montagu," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 553, 602, 611, 620, etc., 1864; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 137, pl. 18, figs. 1, 1*a*, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 36, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 131, 1924; apparently not typical of Montagu's British species.

Bornia luticola Valenciennes, in Du Petit-Thours, Voy. Venus, Atlas, pl. 24, 1846.

Kellia laperousii Deshayes, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 643, 1864; Newcombe, Bull. Nat. Hist. Soc. Brit. Columbia, p. 49, 1893; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1155, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 137, pl. 18, figs. 7, 7*a*, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 36, 1921; Dall, in Orcutt, West American Scientist, Vol. 19, No. 3, p. 23, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 152, 153, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 131, pl. 10, fig. 2, pl. 33, fig. 4, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 5, 1925; Yokoyama, Jour. Faculty Sci., Imper. Univ. Tokyo, Sect. 2, Vol. 1, pt. 9, p. 386, pl. 44, fig. 8, 1926.

Kellia rotundata Carpenter, Jour. de Conchyl., Vol. 12, p. 137, April, 1865; Monterey.

Pleistocene: "Pliocene" of Deadman Island, one valve; lower San Pedro series of San Pedro and Deadman Island, rare (Arnold); lower San Pedro series of Nob Hill cut, San Pedro, "six valves" (T. S. Oldroyd); Pleistocene of Spanish Bight, San Diego (Arnold); lower Pleistocene at Magdalena Bay, and upper Pleistocene at San Quintin Bay, Lower California (Jordan); Pleistocene of Japan (Yokoyama); etc.

Recent: Bering Sea and Pribilof Islands to Panama.

The Pacific coast shells assigned to *suborbicularis* and *laperousii* appear to represent one variable species, which averages larger than the British *C. suborbicularis* (Montagu). The synonymy given above is very much abbreviated.

Genus ALIGENA Lea, 1843

Aligena H. C. Lea, Proc. Amer. Philos. Soc., Vol. 3, p. 163, 1843, *A. striata* and *A. lævis* only species; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1175, 1900.

Type (by subsequent designation, Dall, 1900), *Aligena striata* H. C. Lea.

According to Dall, "the characteristic of this group is the possession of a rounded triangular inflated shell with only a single small anterior tooth under the beaks separated by a gap from the surface of attachment, under the posterior dorsal margin, of an elongate internal resilium carrying a lithodesma. The pallial line is simple, and the cardinal of the left valve more feeble than the other."

Aligena cerritensis Arnold

Aligena cerritensis Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 138, pl. 13, fig. 3, 1903; Dall, Nautilus, Vol. 32, p. 24, 1918; Bull. 112, U. S. Nat. Mus., p. 36, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 132, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: U. S. National Museum, Cat. No. 162,529.

Type locality: Los Cerritos (Signal Hill), near Long Beach, Los Angeles County; Pleistocene.

Pleistocene: Upper San Pedro of Los Cerritos, type locality, two specimens (Arnold); Magdalena Bay Pleistocene, Lower California, Mexico (Dall, 1918); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: La Jolla to Magdalena Bay (Dall, 1921).

This species has a small shell (about 11 mm. in length), somewhat broadly truncated on one end.

Genus ROCHEFORTIA Vélain, 1877

Rochefortia C. Vélain, Archives de Zoologie experimentale et générale, Paris, Vol. 6. pp. 132, 133, pl. 5, figs. 9-11, 1877, only species, *R. australis* Vélain; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1157-59, 1900.

Type (by monotypy), *Rochefortia australis* Vélain, *op. cit.*, p. 133, pl. 5, figs. 9-11, 1877; St. Paul Island, south Indian Sea; Recent.

Dall has given a good discussion and description of this group, and the monotype was well figured by Vélain. It is *Tellimya*, as used by Carpenter, and *Mysella* Angas, 1877, but only in part *Tellimya* Brown.

Rochefortia tumida (Carpenter)

Plate 14, Figures 16, 17

Tellimya tumida Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 643, 1864.
Mysella tumida Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 21, p. 892, pl. 87, fig. 7 (Carpenter's type specimen), 1899.
Rochefortia tumida Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 37, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 132, pl. 54, figs. 11-14, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the U. S. National Museum, Cat. No. 5,242.

Type locality: Vancouver Island, British Columbia; Recent.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico.
Recent: Shumagin Islands, Alaska, to San Diego, California (Dall, 1921).

Genus BORNIA Philippi, 1836

Bornia Philippi, Enum. Moll. Siciliæ, Vol. 1, p. 13, 1836; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, pp. 265, 266, 1871; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1147, 1148, 1900.

Type (by subsequent designation, Stoliczka, 1871), *Bornia corbuloides* Philippi, *op. cit.*, p. 14, 1836, Mediterranean; Recent (according to Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, pp. 235, 236, pl. 39, figs. 1, 2, 1892 = *Cyclas sebatia* da Costa, 1829).

This genus appears to be close to several other named groups. When the family is critically reviewed it is likely that a number of changes in nomenclature will be required.

Bornia retifera Dall

Bornia retifera Dall, Proc. U. S. Nat. Museum, Vol. 21, p. 889, pl. 87, fig. 2, 1899; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 136, pl. 17, fig. 12, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 38, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 137, 1924.

Pleistocene: Lower San Pedro series of Deadman Island, San Pedro Harbor, Los Angeles County, "one right valve" (Arnold).
Recent: Monterey to Santa Barbara Islands, California (Dall).

Genus KELLIA Turton, 1822

Kellia W. Turton, Conch. Insul. Brit., pp. xix, 56, 1822, *Kellia suborbicularis* (Montagu), and *K. rubra* (Montagu) included; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 568, 1847, "Typus: *Cardium rubrum* Mont."
Lasæa Leach, in Brown, Ill. Conch. Gt. Brit., Ed. 1, pl. 20, figs. 17-18, 1827; Ed. 2, p. 93, pl. 36, figs. 17-18, 1844, sole example, *L. rubra* (Montagu); Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1162, 1163, 1900.

Shell very small; hinge variable, rather crude; animal nestling in habit.

Herrmannsen fixed the type of *Kellia* Turton, on *Cardium rubrum* Montagu, which species later served as the sole example of *Lasæa* Leach, in Brown, 1827. Thus, it is necessary to use *Kellia* for the small nestlers which have been called *Lasæa,* and for the Kellias of the *suborbicularis* type the name *Chironia* Deshayes is to be used. These changes, though disconcerting to many, are in accord with the International Code, and as long as the rules are to be followed the sooner such disagreeable rearrangements are made the better.

Kellia rubra (Montagu)

Cardium rubrum Montagu, Test. Brit., p. 83, pl. 27, fig. 4, 1804.

Kellia rubra Montagu, Turton, Conch. Ins. Brit., pp. 57, 58, pl. 11, figs. 7, 8, 1822.

Lasæa rubra Montagu, Brown, Ill. Conch. Gt. Brit., Ed. 1, pl. 20, figs. 17, 18, 1827; Ed. 2, p. 93, pl. 36, figs. 17, 18, 1844; Dall, Bull. 112, U. S. Nat. Mus., p. 38, 1921; Dall, in Orcutt, West American Scientist, Vol. 19, No. 3, p. 23, June, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 138, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the British Museum.

Type locality: British coast.

Pleistocene: San Quintin Bay, Lower California, Mexico (Dall, in Orcutt).
Recent: Vancouver Island, British Columbia, to Callao, Peru; also Atlantic.

This small shell is a nestler, often found in the byssal threads of mussels or in cracks in rocks.

Superfamily CARDIACEA

Lobes of the mantle free behind the siphons, foot elongate, geniculate; sculpture of the shell chiefly radial; cardinal teeth conical, the lateral laminæ short, distant from the cardinals. (Dall.)

Family CARDIIDAE

Shell substance cellulo-crystalline, with the external layer more or less tubular; valves equal, free, gaping slightly behind, the beaks inclined slightly forward, the margins usually serrate or radially striated; adductor scars subequal, the pedal distinct and usually distant; ligament and resilium short, external, set in a groove; cardinal area obscure; complete hinge armature consisting of an anterior and a posterior lateral tooth in the left valve, two anterior and one posterior lateral in the right, any or all of which may be absent, and one cardinal in each valve, usually persistent and well developed; all of the teeth simple, smooth, never bifid. (After Dall.)

Geologic range: Triassic to Recent.

Distribution: Cosmopolitan.

Genus CARDIUM Linnæus, 1758

Cardium Linnæus, Syst. Nat., Ed. 10, p. 678, 1758, *C. costatum,* first species; Children, Quart. Jour. Sci., Lit., Arts, Vol. 14, p. 315, pl. 6, fig. 59, 1823; Gray, Proc. Zool. Soc. London, Pt. 15, p. 185, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1069, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 383, Jan. 2, 1901; Woodring, Carnegie Inst., Publ. No. 366, p. 134, 1925.

Tropidocardium Roemer, Neues Syst. Conch. Cab., Ed. 2, *Cardium,* p. 13, 1869; Dall, 1900; and others.

Type (by subsequent designation, Children, 1823), *Cardium costatum* Linnæus; Indo-Pacific region; Recent.

Shell large, globose, thin for its size, strengthened by a few high, thin, shelly projections or radial costæ; hinge line straight; siphonal gape wide.

A large number of species differing markedly in character from *C. costatum* have been assigned traditionally to the genus *Cardium.* However, a study of *C. costatum* which Children and others have clearly designated as the genotype, shows that it is hardly possible to use the well-known name *Cardium* any longer for the majority of the species to which it has been applied. *C. costatum* is a peculiar form, sculptured with but a few, knife-like ridges that rise more than a quarter of an inch above the smooth general surface of the shell. It differs from the normal *Cardium*-like species as radically in other characters as in sculpture. *Cardium aculeatum* Linnæus has often been considered the genotype because it was selected as an example of the genus by Lamarck in 1799; but Lamarck's action does not constitute designation of type, and however much we might wish to use *aculeatum* for the type, we cannot do it. Furthermore, *aculeatum* is not a normal member of the group that we should like to call *Cardium,* but belongs to *Acanthocardia* Gray,[1] of which it is the type. Most of the species from the Pacific coast of North America that have been known as *Cardium* will fall within a single genus, *Lævicardium.*

Genus LAEVICARDIUM Swainson, 1840

? Didacna Eichwald, Bull. Soc. Imp. Nat. Moscou, p. 166, 1838, species included, *Cardium trigonoides* Pallas and *Cardium crassum* Eichwald = *C. eichwaldi* Kryn. (Bull. des Natur. de Moscou, No. 2, p. 61, 1837); Recent, Caspian Sea.

? Monodacna Eichwald, *op. cit.*, p. 167, 1838.

Lævicardium Swainson, Treat. Malac., p. 373, 1840; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 209, 1871; Bucquoy, Dautzenberg, and Dollfus, 1887; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1076, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 384, 1901; Woodring, Carnegie Inst., Publ. No. 366, p. 144, 1925.

Liocardium Mörch, Cat. Conch. Yoldi, Pt. 2, p. 35, 1853, as of Swainson.

Type (by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1887), *Cardium europæum* Wood = *C. norvegicum* Spengler, European and Mediterranean.

Shell quadrate or subtriangular, inflated, comparatively heavy, radiately ribbed or striated; hinge normal, hinge line curving; without appreciable posterior gape.

Most of the species formerly called *Cardium* are closely related and fall naturally into a single genus. The earliest name available for this group is, apparently, *Lævicardium;* and although the meaning of the name might be misleading, the group of species can be thought of as having lower, less angular, and in that sense more nearly smooth sculpture than *Cardium.* Eichwald's names would be much more appropriate; but they are based on specialized Caspian Sea species, and without figures or specimens the writers do not feel justified in introducing them. It is possible that the Caspian species have changed only a little in the short time since the Caspian Sea has been separated from the open ocean, and that *Didacna* or *Monodacna* could be used in a broad sense in place of *Lævicardium.*[2]

Only in the typical subgenus of *Lævicardium,* as here used, is the ribbing obsolete or nearly obsolete. The other subgenera usually have ribs; but the ribs are usually more numerous, smaller, lower, blunter, and stouter than in true *Cardium. Lævicardium* can also be distinguished from *Cardium* by its curved hinge line, simpler teeth, smaller posterior gape, and usually heavier shell.

Liocardium is an emendation by Agassiz for *Lævicardium* Swainson. The altered spelling was used by Mörch, 1853, Carpenter, 1864, and others.

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[1] List of Specimens of British Animals in the Collection of the British Museum, Pt. 7, p. 23, 1851, type cited by Bucquoy, Dautzenberg, and Dollfus, 1887, *fide* Woodring, 1925.

[2] See Bateson, W.: "On Some Variations of *Cardium edule* apparently Correlated with the Conditions of Life," Philosophical Transactions of the Royal Society of London for the year 1889, Vol. 180, Part B, pp. 297-330, with maps and diagrams, 1890. Bateson follows the changes in characters shown by this species as a result of the increasing salinity of the Aral Sea during the Pleistocene.

Subgenus LAEVICARDIUM, s. s.

Shell of relatively great altitude, valves closed; middle of the valves smooth or feebly radially sculptured, ends with smooth areas; hinge normal, but with the anterior lateral teeth rising from the umbonal cavity; periostracum smooth.

Lævicardium (Lævicardium) elatum (Sowerby)

Cardium elatum G. B. Sowerby, Proc. Zool. Soc. London, Pt. 1, p. 84, Sept., 1833; Conch. Illust., *Cardium*, fig. 3, 1834; Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 8, fig. 41, 1844; Valenciennes, Voy. Venus, Atlas Zool., Moll., pl. 17, fig. 1, 1846; Römer, in Martini und Chemnitz, Conch. Cab., Ed. 2, Cardiacea, p. 93, pl. 13, fig. 7, 1869, Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 74, 1895; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Cardium (*Lævicardium*) *elatum* Sowerby, Carpetner, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 91, 1857; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 391, 1901; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 141, pl. 20, 1903; Lamy, Journ. de Conchyl., Vol. 57, p. 235, 1909; Dall, U. S. Nat. Mus., Bull. 112, p. 40, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 144, 1924.

Liocardium elatum Sowerby, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 246, 1888; Keep, West Coast Shells, p. 181, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 190, 1892.

Lævicardium elatum Sowerby, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 99, 1868-9; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1111, 1900.

Cardium (*Liocardium*) *elatum* Sowerby, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 151, 1894.

Type specimen: In the British Museum.

Type locality: Gulf of California; Recent.

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro series at the north end of San Pedro Bluff and at Los Cerritos, Los Angeles County; Pleistocene at San Diego (Gabb; Dall, 1900).

Recent: San Pedro, California, to Panama (Dall, 1921).

This is an enormous species, with a nearly smooth surface. It is a warm-water shell, occurring in the warm-water upper San Pedro series, now called the Palos Verdes formation, but not found in the cold-water horizons of the California Pleistocene.

Lævicardium (Lævicardium) substriatum (Conrad)

Cardium substriatum Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, p. 228, pl. 17, fig. 2, 1837; Keep, West Amer. Shells, p. 62, 1904; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 251, 1929.

Liocardium substriatum Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 246, 1888; Keep, West Coast Shells, p. 181, fig. 154, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 190, 1892.

Lævicardium substriatum Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 99, 1868-9; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1111, 1900.

Cardium (*Lævicardium*) *substriatum* Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 391, 1901; U. S. Nat. Mus., Bull. 112, p. 40, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 145, 1924.

Type locality: Vicinity of San Diego, California; Recent.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, rare (Arnold, 1903); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan, 1924); Tomales Bay, Marin County (Dickerson); foot of Twenty-sixth Street, San Diego (Arnold; Frank Stephens); upper San Pedro series of Deadman Island, San Pedro, Crawfish George's, and Los Cerritos (Arnold); upper Quaternary at San Ignacio Lagoon and San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926).

Recent: Catalina Island and San Pedro, California, to Acapulco, Mexico (Dall).

This is a small species with a smooth surface. It is closely related to *L. elenense* (Sowerby)[1] of the Panama fauna. It is similar in some respects to the young of *L. elatum;* but immature specimens of Recent *elatum* are mottled with a purple or pink color, whereas *substriatum* is whitish. *L. apicinum* (Carpenter)[2], the type locality of which is Cape San Lucas, is also closely related, but seems to be a smaller, higher-beaked, smoother race than typical *substriatum.* It may be possible to retain the two southern forms in the nomenclature as varieties.

Subgenus **MEXICARDIA** Stewart, 1930

Mexicardia Stewart, Special Publ. No. 3, Proc. Acad. Nat. Sci. Phila., p. 263, 1930.

Type (by original designation), *Cardium procerum* Sowerby.

Shell of relatively great altitude, with few, coarse, squarish ribs.

Unlike *Ringicardium, Mexicardia* is probably closely related to *Lævicardium* and its other subgenera.

Lævicardium (Mexicardia) procerum (Sowerby)

Cardium procerum Sowerby, Proc. Zool. Soc. London, Pt. 1, p. 83, 1833; Conch. Illust., *Cardium,* fig. 23, 1834; Reeve, Conch. Icon., Vol. 2, *Cardium,* pl. 10, fig. 51, 1844; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 91, 1857; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 150, 1894; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1091, 1900; Proc. U. S. Nat. Mus., Vol. 37, p. 157, 1909; McLaughlin and Waring, Calif. State Mining Bureau, Map Folio accompanying Bull. 69, pl. 1, fig. 53, 1914; Dall, Nautilus, Vol. 32, p. 24, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 148, 151, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Cardium laticostatum Sowerby, Proc. Zool. Soc. London, Pt. 1, p. 85, 1833; Conch. Illust., Vol. 1, fig. 30, 1834 (date ?).

Cardium panamense Sowerby, Proc. Zool. Soc. London, p. 85, 1833; Conch. Illust., Vol. 1, fig. 21, 1834 (?); Reeve, Conch. Icon., Vol. 2, *Cardium,* pl. 11, fig. 56, 1844; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 74, 1895.

Cardium subelongatum Valenciennes, Voy. Venus, Atlas Zool. Moll., pl. 17, fig. 2, 1846, not of Sowerby, *fide* Lamy, 1909.

Cardium rotundatum Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 531, 1857, *fide* Lamy, 1909.

Cardium (Ringicardium) procerum Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 389, 1901; Lamy, Jour. de Conchyl., Vol. 57, p. 233, 1909; Dall, Bull. 112, U. S. Nat. Mus., p. 39, 1921 (subgenus cited questionably).

Type locality: Real Llegos, Central America.

Pleistocene: Lower San Pedro series of Deadman Island, San Pedro, "one specimen" (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (Dall, 1918; Jordan, 1924); Spanish Bight and foot of Twenty-sixth Street, San Diego (Arnold); "rather common in the upper San Pedro series of San Pedro, Long Beach, and Los Cerritos (Arnold); upper San Pedro series of Santa Monica (in Oldroyd Collection at Stanford University); upper Quaternary at San Ignacio Lagoon (Jordan, 1924) and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Scammon Lagoon, Lower California, Mexico, to Peru (Jordan, 1924).

This is the common rotund, spiny *Lævicardium* of the Lower California coast.

Subgenus **TRACHYCARDIUM** Mörch, 1853

Trachycardium Mörch, Cat. Yoldi, Pt. 2, p. 34, 1853, list includes *C. isocardia* Linnæus; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 207, 1871; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1073, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 383, Jan. 2, 1901; Woodring, Carnegie Inst., Publ. No. 366, p. 135, 1925.

Granocardium Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 266, 1868-9.

Type (by subsequent designation, Dall, 1901), *Cardium isocardia* Linnæus, West Indies; Recent.

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[1] Proc. Zool. Soc. London, Pt. 8, p. 109, May, 1841.

[2] Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 313, April, 1864.

Shell quadrate; ribs with spines characteristically only on one edge of each rib; valves closed or nearly closed.

As pointed out by Stoliczka, *Granocardium* Gabb is a needless name.

Lævicardium (Trachycardium) consors (Sowerby)

Cardium consors G. B. Sowerby, Proc. Zool. Soc. London, Pt. 1, p. 85, September, 1833; Sowerby, Conch. Illust., *Cardium*, fig. 8, 1834; Sowerby in Reeve's Conch. Icon., Vol. 2, *Cardium*, pl. 17, fig. 86, 1845; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 307, 1857; Römer, in Martini und Chemnitz, Conch. Cab., Ed. 2, Cardiacea, p. 48, pl. 10, figs. 6, 7, 1869; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 150, 1894; Mabille, Bull. Soc. Philomathique de Paris, p. 74, 1895; Lamy, Jour. de Conchyl., Vol. 57, p. 233, 1909; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, Pt. 5, p. 148, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 140, 1927.

Cardium (*Trachycardium*) *consors* Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 389, January 2, 1901; Vol. 37, p. 264, 1909 (as of Broderip and Sowerby).

Pliocene: Coronados Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Jordan); one valve from the Pleistocene of the Santa Rosalia district (collected by M. E. Touwaide).

Recent: Gulf of California, Mexico, south to Guayaquil and the Galapagos Islands.

This southern shell has been well illustrated. A variety with the imbrications twice as distant from each other and more elongated Dall has named *laxum*.

Lævicardium (Trachycardium) quadragenarium (Conrad)

Plate 19, Figure 15

Cardium quadragenarium Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 230, pl. 17, fig. 5, 1837; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 232, 1888; Williamson, Proc. U. S. Nat. Museum, Vol. 15, p. 190, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1091, 1900; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 28, pl. 5, fig. 1, 1920.

Cardium quadrigenarium Conrad, Keep, West Coast Shells, p. 192, 1888, 1892; West American Shells, p. 63, 1904; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 417, 1915; Martin, Vol. 9, p. 251, 1916; Nomland, Vol. 10, pp. 218, 300, 1917; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925.

Cardium (*Trachycardium*) *quadragenarium* Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 389, 1901; Bull. 112, U. S. Nat. Mus., p. 39, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 141, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Shell cordate, subequilateral, ventricose, thick; ribs forty to forty-two, prominent, subangular, flattened at the sides, with a series of small spines which on the middle and posterior parts of the shell are conspicuously placed on the posterior angular margin of the ribs; umbones broad, prominent; beaks not oblique; color pale yellow, with fulvus spots and zones; posterior margin direct, deeply serrate. Height, three inches, according to Conrad.

Type locality: Near Santa Barbara, California; Recent.

Miocene: "Vaqueros-Temblor" (probably Temblor middle Miocene); Santa Margarita formation, upper Miocene, north of Coalinga (Nomland); upper and lower San Pablo, upper Miocene of middle California (Clark).

Pliocene: Jacalitos (Clark) and Etchegoin formations near Coalinga (Nomland); Pico near Ventura (Waterfall); lower part of Merced formation south of San Francisco (Martin); Calleguas Ranch, Ventura County (Cooper).

Pleistocene: Lower San Pedro formation of Nob Hill cut, San Pedro (T. S. Oldroyd); Tomales Bay, Marin County (Dickerson); Pleistocene of Pacific Beach and at the foot of Twenty-sixth Street, San Diego (Arnold); "upper San Pedro series of San Pedro, Los Cerritos and Long Beach Bluff," Los Angeles County (Arnold); "Saugus" formation near Ventura (Waterfall); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Santa Barbara, California, to Todos Santos Bay, Lower California, Mexico (Dall, 1921).

According to Dall, 1901, *Cardium luteolabrum* Gould, 1851, *C. xanthocheilum* (Gould MS.) Carpenter, 1856, *C. arenatum* Carpenter, 1857, and *C. setosum* Tryon, 1872, not Redfield, 1846, are synonyms.

Lævicardium (Trachycardium) quadragenarium (Conrad) variety **fernandoense** (Arnold)

Cardium quadrigenarium Conrad, var. *fernandoensis* Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 535, pl. 48, figs. 2, 2*a*, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 209, 1914.

Type specimen: In the U. S. National Museum, Cat. No. 164,947.

Type locality: Elsmere Canyon, two and a half miles southeast of Newhall, Los Angeles County, California.

Pliocene: Type locality (Arnold); Elsmere and Pico canyons, Los Angeles County (English).

According to Arnold, "This variety is more oblique, has narrower umbones, is relatively less in diameter, and has fewer and less prominently spinose ribs than the typical form." It is likely that some of the occurrences listed under the typical form refer to this variety.

Cardium vaquerosense Arnold[1] from the lower Miocene of Kern and San Mateo counties and from the Temblor formation[2] of Orange County also belongs to this subgenus.

The section *Acrosterigma* Dall[3] is characterized by having an internal elevated mesial rib radiating from the umbonal cavity.

Subgenus **CERASTODERMA** Poli in Mörch, 1853

Cerastoderma Poli, Mörch, Cat. Conch. Yoldi, Pt. 2, p. 34, 1853, list includes *C. edule* Linnæus, and others; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 208, 1871; Meek, Rept. U. S. Geol. Surv. Territories, Vol. 9, p. 166, 1876; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1073, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 384, 1901.

Type (by subsequent designation, Stoliczka, 1871), *Cardium edule* Linnæus; European seas; figured in Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 4, fig. 22, 1844.

Shell more or less quadrate in shape, closed; with strong ribs that are granulose or smooth but not spinose; no posterior or anterior cardinal area; channels simple; hinge normal.

According to Stoliczka, this subgenus begins in the Cretaceous.

Lævicardium (Cerastoderma) corbis (Martyn)

Plate 19, Figures 14, 17

Cochlea corbis Martyn, Univ. Conch., Vol. 2, fig. 80, 1788.

Cardium nuttallii Conrad, Jour. Acad. Nat. Sci. Phila., Vol. 7, p. 229, pl. 17, fig. 3, 1838; Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 13, fig. 66, 1845; Amer. Jour. Conch., Vol. 5, pt. 2, p. 105, 1869.

Cardium nuttallianum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 192, 1857.

Cardium corbis Martyn, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864; Conrad, Amer. Jour. Conch., Vol. 5, Pt. 2, p. 105, 1869; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 207, pl. 4, fig. 36, 1909; Thompson, Report of the B. C. Commissioner of Fisheries for 1912, pp. I-39, I-47, pls. 3, 4, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 417, 1915; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 251, 1916; Nomland, Vol. 10, p. 218, 1917; Edmondson, Science, N. Y., Vol. 49, p. 402, 1919; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 28, pl. 5, fig. 2, 1920; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 310, 1922; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922.

Cardium (*Cerastoderma*) *corbis* Martyn, Dall, Proc. U. S. Nat. Museum, Vol. 23, p. 390, 1901; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 140, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 39, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 142, pl. 34, figs. 1*a*, 1*b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925.

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[1] Proc. U. S. Nat. Museum, Vol. 34, p. 378, pl. 34, fig. 3, 1908; U. S. Geol. Surv., Bull. 396, pl. 9, fig. 2, Jan. 15, 1910.

[2] Univ. Calif. Publ. Geol., Vol. 15, p. 208, 1925.

[3] Trans. Wagner Inst. Sci., Vol. 3, p. 1073, 1900, type designated *C. dalli* Heilprin.

Miocene: Montesano formation of western Washington (Weaver); Quillayute formation of the Olympic Peninsula (Reagan); San Pablo formation, upper Miocene of middle California (Clark); Empire formation of Coos Bay, Oregon (Dall, 1909; Howe).

Pliocene: Merced and Purisima formations of the coast of middle California (Martin); Etchegoin formation of the Coalinga district (Nomland, 1917); Southern California Gas Company's well, No. 1-4, Sec. 4, T. 28 S., R. 23 E., Kern County, depth, 3969 feet, three specimens, upper Etchegoin (H. R. G.); Bath-house Beach, upper Pliocene, Santa Barbara (Arnold, 1903).

Pliocene or *Pleistocene:* Coos conglomerate of Coos Bay, Oregon (Dall, 1909; Howe).

Pleistocene: Tomales Bay, Marin County (Dickerson); lower San Pedro series of Deadman Island and San Pedro (Arnold, 1903); of Nob Hill cut, San Pedro, quite plentiful (T. S. Oldroyd).

Recent: Nunivak, Pribilof, and Commander islands, Bering Sea, south to Hakodate, Japan, and to San Diego, California; ? Lower California (Dall, 1921).

This is a rather large species, with about thirty-seven prominent, closely-set, somewhat rugose ribs. It is larger and has wider ribs than *L. decoratum* (Grewingk).

Lævicardium (Cerastoderma) corbis (Martyn) variety **coosense** (Dall)

Cardium (Cerastoderma) coosense Dall, U. S. Geol. Surv., Prof. Paper 59, p. 118, pl. 13, figs. 3, 4, April 2, 1909.

Cardium coosense Dall, Arnold, U. S. Geol. Surv., Bull. 396, p. 30, January 15, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913; Howe, Univ. Calif. Publ. Geol., Vol. 14, table opp. p. 92, 1922; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 310, 1922.

Cardium coosensis Dall, Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 251, 1916.

Type specimen: In the U. S. National Museum, No. 153,933.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Empire formation, Coos Bay, Oregon (Dall; Arnold and Hannibal; etc.); Montesano formation of western Washington (Weaver); Wildcat formation of northern California (middle Wildcat, Martin; upper, Howe).

Pliocene: Etchegoin formation of Coalinga region (Arnold, 1910); Merced-Purisima Pliocene near San Francisco.

Pliocene or *Pleistocene:* Coos conglomerate, Coos Bay, Oregon (Howe).

Dall gives a detailed description of this form and remarks further: "Although the specimens are far from perfect, the species cannot be referred to any previously known from the coast. The ribs are more compact, more numerous, and less prominent than in *C. ciliatum* Fabricius or *C. corbis* Martyn; the shell is more ovate than in *C. californiense* or its variety *comoxense;* the ribs are much more numerous and the interspaces less channelled than in *C. decoratum; C. meekianum* is much more oblique and has the sculpture absent on the submargins; its ribs are also fewer." However, it seems to the present writers doubtfully distinct.

Lævicardium (Cerastoderma) decoratum (Grewingk)

Plate 19, Figure 12

Cardium decoratum Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 347, pl. 4, figs. 3*a-g*, 1850; Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 844, 1896; Dall, in Spurr, 20th Ann. Rept., Pt. 7, p. 264, 1900; Washington Acad. Sci., Alaska., Repts. Harriman Alaska Expedition, Vol. 4, pp. 114, 121, 1904, reissued by the Smithsonian Institution, 1910.

Cardium (Cerastoderma) decoratum Grewingk, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 390, 1901; U. S. Geol. Survey, Prof. Paper 59, p. 119, 1909; U. S. Nat. Mus., Bull. 112, p. 39, 1921.

Type locality: Alaska; Tertiary.

Miocene: "Tertiary" of Unga, Kadiak, Aläksa, Atcha, St. Paul, in "vulkanischen (?) tuff" (Grewingk); "Miocene" of St. Paul Island, Atka Island, Pavloff Bay, Unga Island, Kadiak Island, also Miocene of British Columbia (Dall, 1896); Cape Yaktag, Alaska (Dall, 1900); Miocene of Coos Bay, Oregon (Dall, 1909).

Pliocene: St. Paul Island, Bering Sea (Dall, 1904-10).

U. Pliocene or *Pleistocene:* Elk River Beds, Oregon.

Pleistocene: Boulder clays of Alaska and British Columbia (Dall, 1909); Douglas Island, near Juneau, Alaska (Dall, 1904).

Recent: (?).

Lævicardium decoratum (Grewingk) is very close to *L. corbis* (Martyn), 1788, but appears to be smaller and to have narrower ribs. There are about twenty-eight to thirty flat-topped ribs about as wide as the interspaces.[1]

Lævicardium (Cerastoderma) californiense (Deshayes)

Plate 19, Figures 13, 16

Cardium californiense Deshayes, Rev. Zool. Soc. Cuv., Vol. 2, p. 360, December, 1839; Guerin, Mag. Zool., Moll., pl. 47, *fide* Dall, 1921; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1093, 1900; Jour. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Howe, Univ. Calif. Publ. Geol., Vol. 14, opp. p. 92, 1922.

Cardium pseudo-fossile Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 10, fig. 52, Dec., 1844.

Cardium blandum Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 276, 1851.

Cardium (Cerastoderma) californiense Deshayes, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 390, 1901; Bull. 112, U. S. Nat. Mus., p. 39, pl. 14, fig. 8, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 143, pl. 2, fig. 3, 1924.

Cardium fucanum Dall, Nautilus, Vol. 20, p. 112, 1907.

Cardium (Cerastoderma) fucanum Dall, U. S. Nat. Mus., Bull. 112, p. 39, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 143, 1924.

Type locality: Puget Sound; Recent (*fide* Oldroyd).

? Miocene: Empire formation of Oregon (Howe).

Pliocene: St. George Island and St. Paul Island, Pribilof group (Dall, 1909); Pliocene of California (Dall, 1900).

Pliocene or *Pleistocene:* Coos conglomerate of Coos Bay, Oregon (Howe).

Recent: Arctic Ocean to San Diego, California; North Japan and Okhotsk Sea (Dall, 1921).

This species is well figured by Reeve (as *pseudo-fossile*), by Dall, and by Oldroyd. It is another member of the closely related *corbis* group. It has from forty to fifty rounded, generally rather smooth ribs.

Lævicardium (Cerastoderma) californiense (Deshayes) variety **comoxense** (Dall)

Cardium californiense Deshayes, var. *comoxense* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1093, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 390, 1901.

Cardium (Cerastoderma) californiense comoxense Dall, U. S. Nat. Mus., Bull. 112, p. 39, 1921.

Type specimen: In the U. S. National Museum.

Type locality: Vancouver Island, boulder clay of Pleistocene age.

Pleistocene: At the type locality (Dall).

Dall separated this variety from the typical because "the ribs are much depressed and flattened, and the interspaces reduced to narrow, shallow grooves." It is possible that erosion would give the ribs a peculiar aspect, but the present authors have not seen specimens of Dall's variety.

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[1] Eichwald, p. 129, 1871, attributes Grewingk's original specimens to the Cretaceous and thinks they might be the same as *Pectunculus umbonatus* Sowerby. See the note on *Mya arenaria* variety *profundior*, p. 414.

Lævicardium (Cerastoderma) meekianum (Gabb)

Cardium meekianum Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 27, pl. 7, fig. 46, 1866; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 232, 1888; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 119, 1909; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 206, pl. 4, fig. 35, 1909, probably only in part; Arnold, U. S. Geol. Surv., Bull. 396, pp. 25, 140, pl. 17, fig. 7, January 15, 1910; Arnold and Anderson, Bull. 398, pp. 108, 125, 312, pl. 39, fig. 7, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 592, 594, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 251, 1916; Howe, Vol. 14, table opp. p. 92, 1922; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 310, 1922; Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 49, 1926.

Miocene: Empire formation of Coos Bay, Oregon (Dall, 1909; Arnold and Hannibal, 1913; Howe, 1922); Wildcat formation, Humboldt County (Martin), perhaps Pliocene.

Pliocene: Jacalitos and Etchegoin formations of Coalinga district (Arnold); Purisima and Merced formations of the San Francisco coastal region and near Sargent (Martin; Arnold and Hannibal); "Fernando" of Fugler's Point, Santa Barbara County (Carson).

Pliocene or *Pleistocene:* Coos conglomerate ? (Howe).

This species resembles *L. corbis*, but has fewer and more rounded ribs becoming distinctly flattened toward the outer border. The beaks are curved and point forward as in *corbis.*

Lævicardium (Cerastoderma) ciliatum (Fabricius)

Plate 19, Figure 11

Cardium ciliatum Fabricius, Fauna Grönl., p. 410, 1780; Reeve, Last of the Arctic Voyages (Belcher), Vol. 2, p. 398, 1855; Sars, Fauna Reg. Arct. Norv., p. 46, pl. 5, figs. 4*a-b*, 1878; Dall, Wash. Acad. Sci., Alaska., Res. Harriman Alaska Exped., Vol. 4, pp. 113, 121, 1904, reissued by the Smithsonian Institution, 1910; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913; Dall, Canadian Arctic Exped., Vol. 8, Pt. A, p. 26A, 1919; Jour. Wash. Acad. Sci., Vol. 9, p. 2, 1919.

Cardium (*Cerastoderma*) *ciliatum* Fabricius, Dall, U. S. Nat. Mus., Bull. 112, p. 39, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 142, pl. 19, figs. 8, 8*a*, 1924.

? Miocene: "Miocene" of Popof Island, Alaska (Dall, 1904).

Pliocene: "Pliocene" near Nome, in the old beaches; Otter Creek; Center Creek, all in Alaska (Dall, 1913); "late Pliocene" of St. George Island and St. Paul Island, Pribilof group (Dall, 1919).

Pleistocene: Pleistocene of Arctic Sound; east side of Coppermine River; south side of Bernard Harbor, Northwest Territories (Dall, 1919); Douglas Island, Juneau Harbor, Alaska (Dall, 1910).

Recent: Arctic Ocean and southward to Puget Sound and northern Japan; also circumboreal (Dall, 1921).

Lævicardium ciliatum has a rather thin, brittle shell. It is somewhat like *L. decoratum*, but has triangular ribs.

Cardium islandicum Chemnitz, 1782; *C. edule* Mohr, 1786, not of Linnæus, 1758; *C. pubescens* Couthouy, 1838; *C. arcticum* Sowerby, 1840; *C. dawsoni* Stimpson, 1862, and *hayesii* Stimpson, 1863; and *C. boreale* Broderip and Sowerby, 1829, not of Reeve, 1844, are probably synonyms of *L. ciliatum* (Fabricius), as suggested by Dall (1901).

Subgenus **NEMOCARDIUM** Meek, 1876

Nemocardium Meek, U. S. Geol. Surv. Territories, Vol. 9, p. 167, 1876; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1078, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 385, 1901; Woodring, Carnegie Inst., Publ. No. 366, p. 146, 1925.

Type (by monotypy), *Cardium semi-asperum* Deshayes; figured by Cossmann and Pissarro, Icon. Coq. Eoc. Env. Paris, pl. 19, figs. 72-7, 1904-6; Paris Basin Eocene.

Shell comparatively small, with fine ribs, the ribs of different character on the posterior part of the shell, being spinose, tuberculate, or cancellate, instead of simple.

Lævicardium (Nemocardium) centifilosum (Carpenter)

Plate 19, Figures 9, 10

Cardium var. *centifilosum* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 642, 1864.
Cardium centifilosum Carpenter, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 99, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 232, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 189, 1892.
Protocardia centifilosa Carpenter, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1113, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 391, 1901; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 142, 1903; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Dall, U. S. Nat. Mus., Bull. 112, p. 40, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 146, pl. 34, figs. *2a-d*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925.

Type locality: Monterey, California; Recent.

? Miocene: Sunol, Alameda County (Cooper).
Pliocene: Lower Fernando of Pico Canyon, Los Angeles County (English); San Diego well, Balboa Park, San Diego (Dall); Southern California Gas Company's well No. 1-4, Sec. 4, T. 28 S., R. 23 E., Kern County, upper Etchegoin, sixteen specimens (H. R. Gale); Packard's Hill, and Bath-house Beach, Santa Barbara (Arnold).
Pleistocene: "Pliocene" of Deadman Island and Timm's Point, "not uncommon;" lower San Pedro of Deadman Island "rare" (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro, three valves (T. S. Oldroyd).
Recent: Bodega Bay, California, to Lower California, Mexico (Dall, 1921).

This species is small, orbicular, and ventricose, with numerous, small, closely-spaced, radiating riblets, the posterior portion of the valves having also concentric sculpture. It differs from *L. substriatum* in its stronger ribbing, in its posterior cancellate sculpture, and in its orbicular shape. *L. substriatum* is slightly elongated at the posterior ventral portion, and the radial sculpture is very low and inconspicuous. *L. centifilosum* has commonly been classified in the genus or subgenus *Protocardia* Beyrich; but as explained below, this classification is now believed to be erroneous.

Genus **PAPYRIDEA** Swainson, 1840

Papyridea Swainson, Treat. Malac., p. 374, 1840; Gray, Proc. Zool. Soc. London, Pt. 15, p. 185, 1847; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 208, 1871; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1075, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 384, 1901.

Type (by subsequent designation, Gray, 1847), *Cardium soleniforme* Bruguière, 1789, = *C. spinosum* Meuschen, Mus. Gever., p. 442, 1787.

Valves elongate-oval, gaping, moderately ventricose or flattened, posterior portion of shell longer than anterior; ribs numerous, narrow, often spiny.

This group is distinguished by being markedly inequilateral.

Papyridea spinosa (Meuschen) variety **aspersa** (Sowerby)

Cardium aspersum G. B. Sowerby, Proc. Zool. Soc. London, Pt. 1, p. 85, Sept., 1833; Conch. Illust., *Cardium*, fig. 15, 1834; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 364, 1857; Römer, Martini und Chemnitz Conch. Cab., Ed. 2, *Cardium*, p. 76, 1869, as "*asperum*."
Cardium bullatum Lamarck, var. *β*, Reeve, Conch. Icon., Vol. 2, *Cardium*, as a variety of fig. 8, pl. 2, 1844.
Cardium (*Papyridea*) *aspersum* Sowerby, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 150, 1894; Dall, Vol. 37, p. 265, 1909.
Cardium variegatum Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 75, 1895, not of Sowerby, 1840.
Cardium (*Papyridea*) *spinosum* Meuschen, var. *aspersum* Sowerby, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1108, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 391, 1901; Lamy, Journ. de Conchyl., Vol. 57, p. 234, 1909.

Pleistocene: Oaxaca, Mexico (collected by R. H. Palmer).
Recent: Magdalena Bay, Lower California, Mexico, south to Guayaquil (Dall, 1909).

Papyridea spinosa (Meuschen) is an Atlantic shell. The Pacific variety *aspersa* is supposed to have less posterior elongation and flatter ribs.

Genus FRAGUM Bolten, 1798

Fragum Bolten, Mus. Boltenianum, p. 189, 1798; Mörch, Cat. Conch. Yoldi, Pt. 2, p. 35, 1853; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 210, 1871; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1074, 1075, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 384, 1901.

Isocardia Oken, Lehrb. Naturg., Vol. 3, p. 234, 1815, in part, not of Lamarck, 1799.

Hemicardium Swainson, Treat. Malac., p. 373, 1840.

Loxocardium Cossmann, Cat. Illust., p. 160, 1887.

Americardia Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 267, 1930, type *Cardium medium* Linnæus.

Type (by absolute tautonymy), *Cardium fragum* Linnæus; Indo-Pacific, Recent; figured by Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 4, fig. 23, 1844.

Shell subtruncate behind, inflated, with strong ribs, no lunule or escutcheon, the channels simple, hinge normal, pallial line nearer the basal margin than in most *Cardia*. (Dall, 1900.)

Fragum fragum is closely related to *F. unedo* (Linnæus), usually cited as the type.

Section FRAGUM, s. s.

Valves obtusely angular in front of the truncation; ribs numerous, strong, pustular, or imbricate throughout. (Dall, 1900.)

Fragum biangulatum (Broderip and Sowerby)

Cardium biangulatum Broderip and Sowerby, Zool. Journ., Vol. 4, p. 367, January, 1829; Sowerby, Conch. Illust., *Cardium*, fig. 2, 1834 (date ?); Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 6, fig. 29, 1844; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 307, 1857; Römer, in Martini und Chemnitz, Conch. Cab., Ed. 2, Cardiacea, p. 104, pl. 14, figs. 12, 13, 1869; Dall, Nautilus, Vol. 32, p. 24, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Hanna and Hertlein, Vol. 16, p. 140, 1927.

Cardium (Fragum) biangulatum Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 390, 1901; Lamy, Journ. Conch., Vol. 57, p. 234, 1909; Dall, U. S. Nat. Mus., Bull. 112, p. 39, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 144, 1924.

Type specimen: In the British Museum, *fide* Oldroyd.

Type locality: St. Elena and Isle of Plata, W. Colombia, *fide* Oldroyd.

Pliocene: Coronados and Carmen islands, Mexico (Hanna and Hertlein).
Pleistocene: Lower Quaternary of Magdalena Bay, west coast of Lower California (Dall, 1918; Jordan, 1924); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1926).
Recent: San Pedro, California, south to Colombia.

This species is characterized by its concavely truncated posterior end, with a produced posterior margin. It has about twenty-eight prominent ribs.

Fragum magnificum (Deshayes in Carpenter)

Cardium planicostatum Sowerby, Conch. Illust., *Cardium*, No. 83, pl. 50, fig. 25, 1834, not *C. planicostatum* Sedgwick and Murchison, 1829.

Cardium magnificum Deshayes, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 187, 1857.

Cardium (Fragum) magnificum (Deshayes MS.) in Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 265, 1901.

Cardium (Fragum) magnificum Deshayes, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 265, 1909.

Pleistocene: Coast of Oaxaca, Mexico (collected by R. H. Palmer).
Recent: Lower California, Mexico, to Paita, Peru (Dall, 1909).

This species is of the same character as *F. biangulatum*, which Carpenter considered a synonym, but it is proportionately higher and has fewer, broader ribs.

Section TRIGONIOCARDIA Dall, 1900

Trigoniocardia Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1075, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 384, 1901.

Type (by original designation), *Cardium graniferum* Sowerby.

Shell small, few ribbed, medial ribs very strong; posterior end subtruncate with smaller, closer ribs; channels strongly concentrically sculptured; shell colorless, periostracum smooth. (Dall.)

Fragum graniferum (Broderip and Sowerby)

Cardium graniferum Broderip and Sowerby, Zool. Journ., Vol. 4, p. 367, January, 1829; Sowerby, Conch. Illust., *Cardium*, p. 3, No. 38, pl. 49, fig. 17, 1834; Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 8, fig. 43, 1844; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1075, 1900; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Cardium (*Trigoniocardia*) *graniferum* Broderip and Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 390, 1901; Vol. 37, p. 265, 1909.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Gulf of California, Mexico, south to Guayaquil (Dall, 1909).

This is a small species with few imbricated ribs.

Genus **RINGICARDIUM** Fischer, 1887

Ringicardium Fischer, Man. Conchyl., p. 1037, 1887; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1073, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 384, 1901.

Type (by monotypy), *Cardium ringens* Chemnitz, = *Cardium ringens* Gmelin; Africa, Recent; figured in Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 1, fig. 6, 1844.

Shell rotund, gaping, with flat ribs and channels, the posterior area with granulose channels; posterior margin sharply spinose, the spines crossing each other over the gape; left cardinals when interlocked posterior to the right ones. (Dall.)

Apparently *Ringicardium* does not apply to the west American species *procerum*, for which Stewart has erected the new subgenus *Mexicardia*. *R. ringens* is smaller, more quadrate in shape, has a slightly straighter hinge line and quite different cardinal teeth. The cardinals of the left valve form a horse-shoe, curving completely around the chief cardinal of the right valve, whereas in *procerum*, as in the other west American subgenera of *Lævicardium*, the chief cardinals (one in each valve) are simple prongs, fitting side by side, and are practically the same in the left valve as in the right. *Ringicardium* is probably more closely related to the true *Cardium* or to *Fragum* than to *Lævicardium*.

Genus **SERRIPES** Beck in Gould, 1841

Aphrodite Lea, Trans. Amer. Philos. Soc., N. S., Vol. 5, p. 111, 1834, only species *A. columba* Lea; not *Aphrodite* Hübner, 1816.

? Adacna Eichwald, p. 169, 1838 (see remarks on *Lævicardium*).

Acardo Swainson, Treat. Malac., p. 374, 1840; not *Acardo* Bruguière, 1789, nor Lamarck, 1799.

Serripes (Beck MS.) Gould, Invert. Mass., p. 93, 1841; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, pp. 209-210, 1871; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1077, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 384, 1901.

Type (by monotypy), *Cardium grönlandicum* Gmelin.

Valves smooth mesially, radially striate toward the ends; cardinal teeth obsolete; pallial line truncate behind; foot geniculate, compressed, serrate on the edge below. (Dall, 1900.)

This boreal genus is readily distinguished by its lack of cardinal teeth. In discussing *Cardium grönlandicum* Gmelin, Gould remarks: "Dr. Lovèn informs me, that Beck has instituted a new genus for it which he calls *Serripes*, on account of the serrated margin of the foot." We have been unable to locate any earlier use of *Serripes* than that of Gould, which would make *C. grönlandicum* the monotype. Stoliczka later (1871) gave this species as the generic type.

Serripes grönlandicus (Bruguière)

Cardium groenlandicum Chemnitz, Neues Syst. Conch. Cab., Vol. 6, p. 202, pl. 19, fig. 198, 1782; Bruguière, Encycl. Méth. Vers, Vol. 1, pt. 1, p. 222, 1789; Gmelin, in Linnæus, Syst. Nat., Ed. 13, p. 3252, 1792; Gould, Invert. Mass., p. 93, 1841; Möller, Index Moll. Groenl., p. 20, 1842.

Cardium boreale Reeve, Conch. Icon., Vol. 2, *Cardium*, pl. 22, fig. 131, 1845, not of Broderip and Sowerby, 1829.

Cardium (Serripes) groenlandicum Chemnitz, Dall, Exped. to Point Barrow, p. 183, 1885.

Serripes gronlandicus "Beck," Dall, 17th Ann. Rept., U. S. Geol. Surv., Pt. 1, p. 844, 1896; Dall, in Spurr, 20th Ann. Rept., Pt. 7, p. 174, 1900.

Serripes grönlandicus Gmelin, Dall, Washington Acad. Sci., Alaska, Repts. Harriman Alaska Exped., Vol. 4, pp. 114, 121, 1904; reissued by the Smithsonian Inst., 1910; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913 (author's name omitted); Dall, Canadian Arctic Exped., Vol. 8, Pt. A, p. 28A, 1919; U. S. Nat. Mus., Bull. 112, p. 40, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 145, pl. 8, fig. 3, 1924.

Type locality: Coast of Greenland.

? Miocene: St. Paul Island, Nushagak, Unga Island, Kadiak Island, Alaska, also British Columbia (Dall, 1896, 1900, 1904).[1]

Pliocene: About one-fourth mile west of Snake River; also second beach one and a half miles east of Nome, Alaska (Dall, in Moffit, 1913).

Pleistocene: Arctic Sound, Northwest Territories; also south side of Bernard Harbor (Dall, 1919); St. Paul Island, Bering Sea; Douglas Island, Juneau Harbor, Alaska (Dall, 1910); also Quebec, etc., *fide* Dall, 1900.

Recent: Arctic seas and south to Hakodate, Japan, and to Puget Sound; also circumboreal (Dall, 1921).

This species has been attributed to Gmelin and to Beck. Chemnitz appears to have been first to describe it, and Bruguière used the name in a strictly binomial manner three years prior to Gmelin's use of it. Most of the synonymy has been omitted in the above tabulation.

Serripes laperousii Deshayes is edentulous (when mature), but noticeably larger.

Serripes laperousii (Deshayes)

Cardium laperousii Deshayes, Révue Zool. Soc. Cuv., p. 360, 1839; Mag. Zool., pl. 48, 1841.

Cardium (? Serripes) laperousii Dall, Amer. Journ. Conch., Vol. 7, p. 148, 1871.

Serripes laperousii Deshayes, Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1112, 1113, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 391, 1901; Bull. 112, U. S. Nat. Mus., p. 40, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 145, 1924.

Pleistocene: "Pleistocene of the Aleutian Islands and of the boulder clay of southeastern Alaska near Juneau." (Dall, 1900).

Recent: Bering Strait to Hakodate, Japan, and Sitka, Alaska (Dall, 1921).

Genus PROTOCARDIA Beyrich, 1845

Protocardia Beyrich, Zeitschr. f. Malak., p. 18, Feb., 1845, *Cardium hillanum* Sowerby included; Herrmannsen, Ind. Gen. Malac., Vol. 2, p. 336, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1078, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 385, 1901; Woodring, Carnegie Inst., Publ. No. 366, p. 146, 1925.

"Protocardium" Beyrich, Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 209, 1871.

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[1] Grewingk also reported this species from the Miocene of Alaska, and some of Dall's reports at least are probably based on Grewingk. Eichwald, however, p. 131, 1871, attributed Grewingk's specimens to the Cretaceous and renamed them *Venus provida*. See the note to *Mya arenaria* variety *profundior*, p. 414. These beds, associated with volcanic tuffs, have been called Miocene so many times, it seems hardly possible they could be Cretaceous.

Type (by subsequent designation, Herrmannsen, 1847), *Cardium hillanum* Sowerby, Min. Conch. Gt. Brit., Vol. 1, p. 41, pl. 14, upper figure, 1813; Cretaceous of England; also figured by Stoliczka, Mem. Geol. Surv. India, Vol. 3, pl. 12, figs. 8-10, 1871.

Shell globose, inflated, closed; sculpture of concentric striations or riblets, except on posterior area which has radial ribs; lunule and escutcheon lacking.

The Cretaceous species of *Protocardia* are so different from *Lævicardium centifilosum* (Carpenter) that it seems unnatural to group the latter in the same genus with them. Typically, *Protocardia* has concentric sculpture except on the posterior area, which is radially sculptured. *L. centifilosum* has radial sculpture on the anterior two-thirds or three-quarters of the shell. The distribution of the two kinds of sculpture is therefore just the reverse. The Cretaceous *Protocardiæ* have a heavy hinge with stout laterals, quite unlike the hinge of the California Recent *L. centifilosum.* These differences are sufficient to remove the California Recent species from Beyrich's genus.

Superfamily VENERACEA

Family VENERIDAE

Shell of trigonal, circular, quadrate, or elongate-quadrate shape, usually heavy, equivalved, with prosogyrous beaks and external resilium embraced by the ligament; surface sometimes smooth and polished, more often sculptured with irregular growth lines, distant concentric grooves, or elevated lamellæ, with or without radial striations or riblets; a shield-shaped area in front of the beaks called the lunule and a lunate area behind the beaks called the escutcheon sometimes marked off by a sharp border and characterized by different sculpture; hinge with two to four, strong, often bifid cardinals in each valve and occasionally an anterior lateral in the left valve, the normal arrangement of the teeth sometimes modified in various ways; pallial sinus usually distinct.

Geologic range: Cretaceous to Recent.

Distribution: World wide.

Various classifications of this very important family have been attempted, perhaps the best known of which is that advocated by Dall.[1] Dall's classification has recently been more clearly elucidated and illustrated by Palmer.[2] However, in some respects this classification is artificial and misleading, and it is not improbable that the radically different classifications proposed by Jukes-Browne,[3] Cossmann,[4] and other Europeans are equally as good. Neither Dall nor the Europeans have adhered strictly to the rules of nomenclature as now understood, and, as a consequence, a certain amount of nomenclatorial revision must be undertaken.[5] In this respect a recent article by Marwick[6] on the New Zealand *Veneridæ* is helpful.

It is unfortunate that the terms lunule and escutcheon are commonly used in a sense almost the reverse of their derived meanings, and it is to be hoped that before long suitable substitutes will be found.

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[1] "Synopsis of the Family Veneridæ and of the North American Recent Species," Proc. U. S. Nat. Mus., Vol. 26, pp. 335-412, pls. 12-16, December 29, 1902; Trans. Wagner Inst. Sci., Vol. 3, pp. 1219-1334, October, 1903.

[2] Katherine Van Winkle Palmer, Palaeontographica Americana, Vol. 1, no. 5, pp. 209-522, March, 1927; pls., 1929.

[3] Proc. Malac. Soc. London, Vol. 8, pp. 148-177, pl. 6, 1908; pp. 233-246, 1909; Vol. 10, pp. 36-38, 1912; pp. 95-104, 1912; Vol. 11, pp. 58-94, 1914.

[4] Ann. Soc. Roy. Malac. Belg., Vols. 21, 22, 1886-7.

[5] Pressure of other work has limited the time which the present authors could devote to this family. A careful discussion of the California Pliocene and Pleistocene *Veneridæ* must await a more propitious occasion.

[6] Trans. New Zealand Inst., Vol. 57, pp. 567-635, pls. 34-54, Feb., 1927.

Genus VENUS Linnæus, 1758

Venus Linnæus, Syst. Nat., Ed. 10, p. 684, 1758; Children, Quart. Journ. Sci., Lit., Arts., Vol. 14, p. 314, 1823; Gray, Proc. Zool. Soc. London for 1847, p. 183, 1847, type *V. verrucosa* Linnæus.

Type (by subsequent designation, Gray, 1847), *Venus verrucosa* Linnæus, *op. cit.*, p. 685, 1758; figured by Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 135, pl. 10, fig. 3 (hinge), 1817; Reeve, Conch. Icon., Vol. 14, pl. 12, figs. 40*a*, 40*b*, 1863; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 368, pl. 57, figs. 1-6, 1893; Recent along the coasts of England and southern Europe to Africa, also Mediterranean; Pliocene of Europe; Pleistocene of England; etc.

Shell moderately large and heavy, of a rounded subtrigonal outline, sculptured with concentric striæ or growth lines and sometimes raised lamellæ and radial striations or riblets, escutcheon and lunule both defined; hinge rather heavy and broad, with a posterior smooth or roughened platform-like area of variable width behind the teeth, when narrow this area compressed into a long ill-defined ridge, but when wide bordered on the anterior edge by a tooth-like ridge set off by a groove, anterior to the platform-like area in the left valve two cardinal teeth, the posterior of which is bifid, and a more or less developed anterior pustule (occasionally the posterior ridge described above is sufficiently well defined to be called a tooth, in which case there are three cardinals), in the right valve three cardinals in addition to the posterior ridge, the posterior and middle ones being bifid or tending to be so; pallial sinus distinct, short; inner margins of valves crenulated or fluted.

Apparently the earliest valid type designation was that of Gray, who definitely selected *Venus verrucosa* as the type of the genus. Lamarck, in 1799,[1] used *V. mercenaria* as an example; but in 1801,[2] he used *V. verrucosa* as the example. Neither of these passages can be construed as type designations; and to interpret them as such would lead to confusion.[3]

Subgenus **ANTIGONA** Schumacher, 1817

Cytherea Bolten, Mus. Boltenianum, p. 177, 1798; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 354, 1902; Trans. Wagner Inst. Sci., Vol. 3, pp. 1271, 1272, 1273, 1903; not *Cytherea* Fabricius, Ent. Syst., Vol. 4, p. 413, 1794, *Diptera*.
Antigona Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 154, 155, pl. 14, fig. 2, 1817; Woodring, Carnegie Inst., Publ. No. 366, p. 156, 1925; Marwick, Trans. New Zealand Institute, Vol. 57, p. 598, 1927.

Type (by monotypy), *Antigona lamellaris* Schumacher, *op. cit.*, p. 155, pl. 14, fig. 2, 1817; Indo-Pacific, Recent.[4]

Shell similar to that of *Chione*; but with a small part of the anterior cardinal in the left valve separated off into a pseudolateral, and a corresponding pit in the right valve.

Marwick (1927) has shown[5] that the anterior lateral tooth in the left valve of *Antigona* is not of the same origin as the anterior lateral in *Dosinia, Pitar, Macrocallista, Meretrix*, etc., and that its classification with the latter is purely artificial. *Antigona* is more closely related to *Venus* and to *Paphia*.

Venus (Antigona) multicostata Sowerby

Venus multicostata Sowerby, Proc. Zool. Soc. London for 1835, p. 22, June, 1835; Thes. Conch., Vol. 2, p. 706, pl. 152, fig. 10, 1853; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 3, fig. 9, 1863; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 528, 569, 1864.
Cytherea (Cytherea) multicostata Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 390, 1902.

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[1] Mém. Soc. Hist. Nat. Paris, p. 84, 1799.

[2] Syst. Anim. s. Vert., p. 123, 1801.

[3] Murray, Fund. Test., p. 148, pl. 3, figs. 11, 16, 17, 1771, is said to have given *Venus dione* Linnæus as the sole example of the genus. We have not seen Murray's work.

[4] Unfortunately, there is a complication over the type of *Antigona*. Schumacher identified his figure with *Venus cancellata* Linnæus, which is the type of *Chione;* but as he referred to Chemnitz's conception of *cancellata*, it may be possible to avoid the loss of *Antigona* under *Chione*.

[5] The left anterior lateral of *Macrocallista* is the continuation of a low ridge proceeding from below the umbo, whereas the anterior lateral of *Antigona* is a prolongation of the front limb of the anterior triangular cardinal tooth. Ontogenetic studies by Marwick have proved the latter mode of development in *Kuia vellicata* (Hutton).

Shell large, heavy, subovate, moderately ventricose, with small umbones and more or less rounded profile; sculptured with concentric, umbonally-reflected lamellæ and occasionally with low, uniform, flattened ribs; lunule of moderate size, sharply delimited by a sinus, escutcheon of moderate size; right hinge with three cardinals, the middle and posterior heavy and lightly mesially grooved, left hinge with three cardinals, the posterior one an elongate ridge on the base of the nymph, and a small pseudo-lateral near the base of the strong front cardinal; pallial sinus small, rounded at the apex.

Pleistocene: Coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Gulf of California, Mexico, south to Panama (Dall).

This species is very different from *Antigona fordi* (Yates). *Venus thouarsi* Valenciennes is probably a synonym.

A number of species assigned to *Antigona* have been reported from pre-Pliocene horizons in California, some of which appear to belong to other genera.

Venus (Antigona) fordii Yates

Venus fordii Yates, Santa Barbara Soc. Nat. Hist., Bull. No. 2, p. 46, pl. 1, figs. 1-5, 1890.

Cytherea (*Ventricola*) *fordi* Yates, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 390, 1902.

Antigona fordi Yates, Dall, U. S. Nat. Mus., Bull. 112, p. 41, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 152, 1924.

Shell heavy, subtrigonally ovate, strongly ventricose, with prominent, strongly curved beaks, wide, depressed lunule, and wide escutcheon delimited by radial threads; sculptured by concentric striæ superposed on concentric undulations, and radial riblets; hinge of the right valve with three strong cardinal teeth, the middle one stoutest, hinge of the left valve with two cardinals, a posterior lamellar ridge beneath the ligament, and a small conical pseudo-lateral just anterior to the front cardinal, fitting into a corresponding pit in the right hinge plate; pallial sinus small, angular.

Type locality: Santa Barbara Channel, California.

Pleistocene: San Pedro.
Recent: Monterey, California, to Lower California; ? Panama (Dall, 1921).

This species belongs to the group *Ventricola* Römer.[1] Its inflated, *Isocardia*-like appearance is very different from that of *multicostata*.

Subgenus **VENUS**, s. s.

Shell with strong concentric lamellæ and secondary low radial undulations or ribs arranged divaricately; hinge with a faint anterior pseudolateral in the left valve.

Venus mercenaria Linnæus has generally been considered the type of the genus *Venus*, but according to the International Rules the type must be *Venus verrucosa*. This changes *Venus, sensu stricto,* of most recent authors to *Mercenaria* Schumacher, which can now be considered a subgenus of *Venus*. The type of *Chione* is so similar to the type of *Venus*, represented by *V. verrucosa*, that it appears to be hardly more than sectionally distinct.

The true *Venus* must be considered intermediate between *Antigona* and *Chione,* the anterior pustule being exceedingly faint and probably not of very great significance. Until typical *Venus* can be more closely allied to one or the other of these groups, it will probably be of little importance as a subgenus. *Venus verrucosa* has a relatively narrower and longer hinge plate than *V. cancellata*, which is a result of the more trigonal shape of the latter. It should be noted that the small, narrow anterior cardinal tooth of both is quite variable in strength.

The sculpture patterns of *V. verrucosa*, the type of *Venus*, and of *V. cancellata*, the type of *Chione,* illustrate the chief difference between these subdivisions of *Venus, sensu*

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[1] Malakozool. Blätter, Bd. 14, p. 115, 1867, type by subsequent designation (Dall, 1902), *Venus rugosa* Gmelin (= V. *rigida* Dillwyn); West Indies, Recent, *fide* Woodring, 1925.

lato. *V. verrucosa* has rather close-set concentric lamellæ, which are each multiple, being generally composed of about three appressed lamellar folds leaning in an umbonal direction, whereas *V. cancellata* has distant, generally single, more erect, often sharp, concentric lamellæ or frills. In the umbonal region the sculpture, both radial and concentric, of these two types is approximately identical; but during the growth of the shells the radial sculpture of the one becomes radically different in character from that of the other. In passing from the umbonal region to the ventral margin, the radial riblets must cover an increasing amount of area. On the valves of *verrucosa* this area is filled by the addition of fully-developed ribs along an axis of divarication, generally posterior to the medial axis, as well as by a constant increase in the width of the ribs ventrally. On *cancellata* the ribs divide into several parts as the area which they must cover increases, producing temporarily bunches or fascicles of riblets, which ultimately, with the growth of the shell, become a uniform series of equal ribs.

The specimens of *V. cancellata* in the collections at Stanford University average smaller and flatter than those of *verrucosa*. Also the escutcheon of the former species is larger and the shell more trigonal, but these differences appear to be little more than specific. The right valves of some specimens show a slight prominence below the ligament, indicating the position of a possible fourth cardinal tooth.

Clausina Brown, according to Dall's usage, 1903, is an exact synonym of the typical subgenus of *Venus* as here understood.

Subgenus **CHIONE** Megerle von Mühlfeld, 1811

Chione Megerle von Mühlfeld, Gesellschaft Naturf. Freunde zu Berlin, Jahrg. 5, p. 51, 1811, *fide* Woodring, 1925; Gray, Proc. Zool. Soc. London for 1847, p. 183, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1286, 1287, 1903; Woodring, Carnegie Inst., Publ. No. 366, p. 159, 1925.

Type (by subsequent designation, Gray, 1847), *Venus dysera* Chemnitz = *Venus cancellata* Linnæus, Syst. Nat., Ed. 12, p. 1191, 1767; West Indies, Recent.

Shell like that of *Venus, sensu stricto*, but with ribs increasing by division, not by divarication along an axis, and with concentric sculpture of more distant lamellæ appearing as erect frills; hinge generally heavier, the left valve without the anterior pustule; escutcheon larger.

Venus (Chione) gnidia Broderip and Sowerby

Plate 16, Figures *5a*, *5b*

Venus gnidia Broderip and Sowerby, Zool. Journ., Vol. 4, p. 364, January, 1829; Sowerby, Gen. Rec. Moll., Pt. 41, pl. 251, fig. 7, 1834; Gray, Zool. Beechey's Voy., Moll., p. 151, pl. 41, fig. 3, 1839; Sowerby, Thes. Conch., Vol. 2, p. 709, pl. 154, fig. 25, 1853; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 11, fig. 37, 1863; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 561, 1864.

Venus (Chione) gnidia Broderip and Sowerby, Carpenter, Cat. Reigen Coll. Mazat. Moll. Brit. Mus., p. 71, 1857; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 147, pl. 14, fig. 7, 1903; Lamy, Journ. Conchyl., Vol. 57, p. 245, 1909.

Chione gnidia Broderip and Sowerby, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 153, 1894; Dall, Vol. 26, p. 394, 1903; McLaughlin and Waring, Calif. State Mining Bureau, Bull. 69, Map Folio, pl. 1, fig. 52, 1914; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.

Shell large, heavy, of a subtrigonal shape, posterior dorsal margin broadly curving to a rather acutely rounded posterior ventral extremity, immediately below which the ventral margin is slightly indented, anterior dorsal margin concave, moderately curving, turning abruptly into the strongly convex anterior curve; sculpture of distant, high, concentric frills and prominent radial riblets; hinge normal, the posterior area somewhat restricted, the bifurcation of the middle left cardinal anterior to the middle of the tooth, the anterior right cardinal well separated from the shell margin. Size up to 114 mm. in height, and 120 mm. in length.

Pleistocene: "Rare in the upper San Pedro series of San Pedro" (Arnold); Pleistocene of Signal Hill (in Oldroyd Collection at Stanford University; McLaughlin and Waring); Clark's well, near Encinitas, San Diego County (Mrs. Kate Stephens, MS.); northeast shore of Mission Bay, San Diego County (Frank Stephens); upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).
Recent: Cedros Island, Lower California, Mexico, to Paita, Peru.

The geologic history of this well-characterized species is not yet fully understood. It is very closely related to *V. elsmerensis*, from which it is distinguished by its more abruptly truncated anterior extremity and by the details of the hinge. Weathering usually disguises the sculpturing of *V. elsmerensis*. It is also similar to *V. temblorensis* of the California Miocene, but this latter species and a Recent species in the Gulf of California have more acute posterior extremities. *Venus richthofeni* (Hertlein and Jordan),[1] from the Miocene of Lower California, much resembles the young of *gnidia*. It may be the same as the Recent Gulf species, which would give the latter a range of Miocene to Recent.

The occurrence of *V. gnidia* in some of the Pleistocene faunas of California helps to show that temperatures warmer than the present prevailed at times during the Pleistocene.

Venus (Chione) elsmerensis (English)

Plate 16, Figures 6*a*, 6*b*, 7

? "*Chione gnidia* Sowerby," Watts, Calif. State Mining Bureau, Bull. No. 3, p. 54, 1894.
Chione elsmerensis English, Univ. Calif. Publ. Geol., Vol. 8, p. 214, pl. 23, figs. 1*a*, 1*b*, 1914; Nomland, Vol. 9, p. 202, pl. 9, figs. 3*a*, 3*b*, pl. 10, fig. 1, 1916; Vol. 10, p. 218, 1917.
? "*Chione pabloensis* ?", Clark, Univ. Calif. Publ. Geol., Vol. 8, pl. 58, fig. 1, 1915.

Shell like that of *Venus gnidia* but with a longer and more rounded anterior extremity, a narrower posterior right cardinal, a more symmetrically bifurcated middle left cardinal, and possibly coarser radial sculpture.

Type specimen: In the University of California collection.

Type locality: Elsmere Canyon, Los Angeles County; Univ. Calif. locality 1735; lower Pliocene.

? *U. Miocene:* Specimen from the San Pablo formation questionably identified as *pabloensis* by Clark.
Pliocene: Lower Pliocene of Elsmere Canyon, Los Angeles County (English); common in *Chione elsmerensis* zone, lower Pliocene, Coalinga district, California (Nomland, 1917); ? near Tar Canyon, Kings County (as *gnidia*, Watts).

This species is somewhat intermediate between *V. gnidia* and *V. securis*. It is distinguishable from the latter by its higher and more central beaks with more extended anterior, and probably also by its hinge. The details of the hinge vary considerably in different individuals.

Venus (Chione) temblorensis Anderson

Venus (Chione) temblorensis Anderson, Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 196, pl. 14, figs. 36-38, 1905; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 542, pl. 43, figs. 1, 1*a*, 1907, figures reproduced in U. S. Geol. Surv., Bull. 309, pl. 30, figs. 1, 1*a*, 1907; probably not "*Venus (Chione) temblorensis* (Anderson)," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 182, 1909, *fide* Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 307, 1922, which may be *Venus securis* Shumard.

Type specimen: Formerly at the California Academy of Sciences, but lost in the San Francisco earthquake.

Type locality: "Lower Miocene beds of Kern River and Temblor."

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[1] Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 619, pl. 17, figs. 4, 7, 8, 1927.

Miocene: "Lower Miocene beds of Kern River and Temblor" (Anderson); head of Topanga Canyon, Los Angeles County [Temblor formation], (Arnold).

The shape of this species, as figured, resembles *Venus darwini* Dunker of the Gulf of California Recent fauna. They both belong to the *gnidia* clan. *V. temblorensis* may be the ancestor of *securis* Shumard.

Venus (**Chione**) **securis** Shumard

Plate 17, Figure 1

Venus securis Shumard, Trans. St. Louis Acad. Sci., Vol. 1, p. 122, 1858; Arnold and Hannibal, Trans. Amer. Philos. Soc., Vol. 52, pp. 590, 593, 594, 1913.

Chione securis Shumard, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 120, pl. 11, fig. 8, pl. 13, figs. 2, 8, 9, April 2, 1909; Arnold, U. S. Geol. Surv., Bull. 396, p. 136, pl. 15, fig. 2, January 15, 1910; Arnold and Anderson, Bull. 398, p. 108, pl. 37, same figure, 1910; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 239, 245, 1916; Howe, Vol. 14, p. 92, 1922; Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 307, 1922.

Shell of medium size, elongate-trigonal, the posterior dorsal margin long and but slightly curved, at the extremity curving abruptly into the strongly convex ventral margin, anterior extremity short, the anterior dorsal margin descending abruptly and partly concavely from the beaks; sculpture similar to that of *V. gnidia* but weathered into various aspects; hinge similar to that of *gnidia*.

Variety **securis,** s. s.

Valves relatively compressed.

Miocene: Montesano formation, middle Miocene of western Washington (Weaver); Empire formation of Coos Bay, Oregon (Arnold and Hannibal; Dall; Howe).

Pliocene: Upper Wildcat formation, Humboldt County, California (Martin); Merced and Purisima formations of middle California (Arnold and Hannibal); Etchegoin formation of Coalinga region (Arnold; Martin); Etchegoin of Sargent oil field (Martin).

Venus (**Chione**) **securis** Shumard variety **ensifera** Dall

Plate 17, Figures 2*a*, 2*b*, 3

Venus lamellifera Conrad, Geol. U. S. Expl. Exped., p. 724, Atlas, pl. 17, figs. 12, 12*a*, 1849; Amer. Journ. Conch., Vol. 1, p. 152, 1865; not *V. lamellifera* Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 251, pl. 19, fig. 19, 1837.

Venus ensifera Dall, U. S. Geol. Surv., Prof. Paper 59, p. 122, 1909, new name for *lamellifera*.

Venus parapodema Dall, *op. cit.*, p. 122, pl. 11, fig. 11, pl. 13, fig. 1, 1909.

Venus (*Chione ?*) *clallamensis* Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 183, pl. 1, fig. 13, Nov., 1909.

Shell like that of the typical variety but more ventricose.

Type specimens: In the U. S. National Museum.

Type localities: Of *V. ensifera* Dall, Astoria, Oregon, Miocene; of *V. parapodema*, Coos Bay, Miocene; of *clallamensis*, East Clallam, Washington, Miocene.

Miocene: Middle and upper Miocene of Oregon and Washington.

This variety occurs with and intergrades with the typical variety, the intergrades being more common than the extremes. An examination of a series of specimens shows that the manner of weathering is the cause of different appearances which are not due to differences in the characteristics of the shells. It is strange that Dall took no account of this factor. More specimens may show that *Venus pabloensis* (Clark), from the upper Miocene of middle California, is another synonym.

Venus (Chione) securis Shumard variety **fernandoensis** (English)

Plate 17, Figures 4*a*, 4*b*, 5, 6

Chione new species, Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 526, 1907.
Chione fernandoensis English, Univ. Calif. Publ. Geol., Vol. 8, p. 215, pl. 23, figs. 9*a*, 9*b*, 1914; Nomland, Vol. 10, p. 218, 1917; Waterfall, Vol. 18, pp. 78, 79, 1929.

Shell like that of the variety *ensifera*, but smaller, with more sharply defined lunule and escutcheon.

Type specimen: In the University of California collection.

Type locality: Elsmere Canyon, Los Angeles County, lower Pliocene.

Pliocene: Lower Pliocene of Elsmere, Holser, and Pico canyons, Los Angeles County (English, p. 209); S. D. S. N. H. localities 206 and 209, lower Pliocene of Elsmere Canyon, and loc. 217*b*, middle Pliocene of Holser Canyon (H. R. Gale); Pico formation near Ventura (Waterfall).
? Pleistocene: "Saugus" formation near Ventura (Waterfall), this occurrence questioned by the present writers.

It is not unlikely that the differences between this variety and the variety *ensifera* are due entirely to the state of preservation. Hitherto this form has been known from small or stunted individuals such as are shown in figures 5 and 6, but the specimen shown in figures 4*a* and 4*b* is unquestionably the same and indicates the more normal aspect of this variety.

From the "lower series at East Clallam," Washington, probably Oligocene, Reagan[1] described a *Venus* (*Chione ?*) *olympidæ* from a single cast. Years later, in examining the specimen, Dall[2] assigned it to *Antigona*, and remarked that the "few particles remaining of the external layer of the shell indicate a finely reticulate sculpture." The specimen should be compared with a similar poor cast of *Venus mediostriata* (Clark)[3] of the basal *Agasoma gravidum* beds of middle California.

Venus (Chione) securis Shumard variety **semiplicata** (Nomland)

Chione semiplicata Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 305-6, pl. 15, figs. 2*a*, 2*b*, 2*c*, November 8, 1917.

Type specimen: In the University of California collection, No. 11,318.

Type locality: About nine miles northeast of Coalinga, upper Miocene.

Miocene: Santa Margarita formation at the type locality, about nine miles northeast of Coalinga, California.

This variety is characterized by the gently and broadly rounded posterior extremity. It is of low convexity like the typical variety.

Venus (Chione) succincta Valenciennes

Plate 16, Figures 1*a*, 1*b*, 2*a*, 2*b*, 3, 4

Venus succincta Valenciennes, in Humboldt and Bonpland, Rec. Obs. Zool., Vol. 2, p. 219, pl. 48, figs. 1*a-c*, 1821; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 521, 641, 666, 1864.
Venus californiensis Broderip, Proc. Zool. Soc. London for 1835, p. 43, June, 1835; Sowerby, Thes. Conch., Vol. 2, p. 711, pl. 154, figs. 40, 41, 1853; Reeve, Conch. Icon., *Venus*, Vol. 14, pl. 11, fig. 35, 1863.
Venus leucodon Sowerby, Proc. Zool. Soc. London for 1835, p. 43, June, 1835.
Venus undatella Sowerby, Proc. Zool. Soc. London for 1835, p. 22, June, 1835; Thes. Conch., Vol. 2, p. 711, pl. 153, fig. 22, 1853.

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[1] Trans. Kansas Acad. Sci., Vol. 22, p. 182, pl. 1, fig. 12, 1909.

[2] Amer. Journ. Sci., Ser. 5, Vol. 4, p. 307, 1922.

[3] Univ. Calif. Publ. Geol., Vol. 11, p. 150, pl. 5, figs. 5, 6, pl. 6, figs. 3, 4, 1918.

Venus californiana Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 251, pl. 19, fig. 16, 1837.

Venus nuttalli Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 250, pl. 19, fig. 15, 1837.

Venus neglecta Sowerby, Zool. Beechey's Voy., Blossom, p. 151, pl. 41, fig. 8, 1839; Thes. Conch., Vol. 2, p. 710, pl. 154, fig. 39, 1853.

Venus entabapta Jonas, Zeitschr. f. Malakzool., p. 66, 1845.

Venus simillima Sowerby, Thes. Conch., Vol. 2, p. 708, pl. 153, figs. 17, 18, 1853; Reeve, Conch. Icon., *Venus*, Vol. 14, pl. 13, fig. 44, 1863.

"*Venus subrostrata* Lamarck," Sowerby, Thes. Conch., Vol. 2, p. 710, pl. 154, fig. 39, 1853; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 14, figs. 54*a*, 54*b*, 1863; ? of Lamarck, 1818 ? (original reference not consulted).

Venus excavata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 305, 351, 1857.

Venus bilineata Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 22, figs. 105*a*, 105*b*, 1863.

Venus crassa Sloat MS., Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 566, 569, 1864, not *V. crassa* Quoy.

Chione simillima Sowerby, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 234, 1888.

Chione succincta Valenciennes, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 94, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 234, 1888; Keep, West Coast Shells, p. 187, fig. 159, 1888, 1892; West American Shells, p. 70, fig. 56, 1904; Rev. Edition, p. 80, fig. 54, 1911; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 251, 1916; Dall, Nautilus, Vol. 32, p. 24, 1918; Weymouth, Calif. State Fish and Game Comm., Fish Bull. No. 4, pl. 9, fig. 3, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 42, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 154, 1924; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 148, 151, 152, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1924; Hanna and Hertlein, Vol. 16, p. 140, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Venus (*Chione*) *succincta* Valenciennes, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 152, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 149, pl. 14, fig. 1, 1903; Lamy, Journ. Conchyl., Vol. 57, pp. 244, 245, 1909.

Chione (*Chione*) *succincta* Valenciennes, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 392, 1902.

Chione (*Chione*) *undatella* Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 392, 1902.

Venus (*Chione*) *simillima* Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 148, 1903.

Chione undatella Sowerby, Dall, Nautilus, Vol. 32, p. 24, 1918; Weymouth, Calif. State Fish and Game Comm., Fish Bull. No. 4, pp. 12, 37, 67, pl. 9, fig. 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 42, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 154, pl. 55, fig. 2, 1924; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, pp. 560, 563, 1922; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 251, 255, 1929.

Chione simillima Sowerby, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Shell of medium size, heavy, of variable outline; sculptured with strong concentric lamellæ and radial ribs, the radial ribs often differentiated into stronger pairs separated by smaller single intercalaries, but both concentric and radial sculpture variable in relative strength and disposition; teeth short and thick, seldom grooved, the anterior right cardinal small.

Miocene: "Oregon; Martinez; San Pablo, Contra Costa County; Griswold's, San Benito County; Foxin's, Santa Barbara County; Santa Monica, Los Angeles County" (Cooper, as *succincta;* several of these records probably apply to some other species).

Pliocene: Middle Wildcat formation, Humboldt County (Martin); Seven Mile Beach, San Mateo County; San Fernando, Los Angeles County (Cooper); "Pico" formation near Ventura (Waterfall); Santa Antonita Point; Coronados Island; Carmen Island, Gulf of California, Mexico (Hanna and Hertlein); upper conglomerate formation, Santa Rosalia district, Lower California, Mexico, one right valve (coll. by Marcel Touwaide).

Pleistocene: Lower San Pedro series at Deadman Island, "rare"; Barlow's Ranch, Ventura (Arnold); "Saugus" near Ventura (Waterfall); Pleistocene at Tomales Bay, Marin County (Dickerson); Lower Quaternary at Magdalena Bay, Lower California, Mexico (Dall, 1918; Jordan, 1924); upper San Pedro series (= Palos Verdes formation) at various localities in San Pedro and vicinity (Arnold; etc.); upper Pleistocene at foot of 26th Street, San Diego (Arnold; Stephens); northeast end of Point Loma (loc. 70) and two miles north of Del Mar (Stephens); about 5 miles east-northeast of Newport, in Orange County, loc. 97 (coll. by Wayne Loel); etc.

Recent: San Pedro, California, south to northern South America.

Venus (*Chione*) *succincta* Valenciennes is greatly over-supplied with names on account of the attractive and variable nature of the shell and the failure of authors to realize that a considerable degree of individual variation is a zoological feature well substantiated by proof in many well-known instances. Several specimens of this species all from the same locality are illustrated on plate 16 to show the variation of its shape and sculpture. The relative height of the shell and the frequency of the concentric lamellæ are of little significance. These same variants are found nearly everywhere that the species occurs. The hinges are also somewhat variable.

Weymouth (1920) figures two extreme variants, one known as *undatella*, the other as *succincta*. His figures are exceptionally clear.

Venus (Chione) fluctifraga Sowerby

Venus fluctifraga Sowerby, Thes. Conch., Vol. 2, p. 712, pl. 154, figs. 42, 43, 1853.
"*Venus callosa* Conrad" Sowerby, Thes. Conch., Vol. 2, p. 712, pl. 154, figs. 44, 45, 1853.
? *Venus gibbosula* Deshayes, Proc. Zool. Soc. London for 1853, p. 7, 1853, habitat unknown.
"*Venus gibbosula* Deshayes, MS.", Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 13, fig. 47, 1863.
Venus cortezi Sloat MS., Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 570, 1864.
Chione fluctifraga Sowerby, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 234, 1888; Weymouth, Calif. State Fish and Game Comm., Fish Bull. No. 4, p. 37, pl. 9, fig. 1, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 42, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 153, pl. 39, fig. 3, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.
Chione (Chione) fluctifraga Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 392, 1902.
Venus (Chione) fluctifraga Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 147, pl. 14, fig. 2, 1903.

Shell of medium size, heavy, outline varying from nearly orbicular to subtrigonal; sculptured with radial ribs and concentric cords somewhat undulose at their intersections, the posterior third or less of the valves sculptured differently, with fewer but coarser radials and weaker or almost obsolete concentric sculpture; hinge characters like those of *succincta*, but the anterior right cardinal tooth sometimes absent.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); "Saugus" formation near Ventura (Waterfall); "rare in upper San Pedro series at San Pedro;" "common in the Pleistocene at Twenty-sixth Street, San Diego" (Arnold).

Recent: San Pedro, California, to the Gulf of California, Mexico (Dall).

This species is readily distinguished from *succincta* by the difference between the posterior sculpture and that of the other parts of the valve. Sowerby gave *Australia* as the habitat, which is probably an error. If *fluctifraga* came originally from Australia, the California species would have to take one of the later names.

The sculpture and shape of this species are variable. Some specimens are somewhat oblique or trigonal while others are nearly orbicular in profile. Sowerby's figure of the interior of a right valve shows an unusually deep pallial sinus.

There are a number of species belonging to *Chione* in the Miocene formations of California which cannot be discussed here. "*Venus*" *pertenuis* Gabb and *martini* Clark[1] of the Miocene belong to *Clementia*.

Section Lirophora Conrad, 1863

Lirophora Conrad, Proc. Acad. Nat. Sci. Phila. for 1862, pp. 575, 586, 1863; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 358, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1288, 1903; Woodring, Carnegie Inst., Publ. No. 366, p. 162, 1925.

Type (by subsequent designation, Dall, 1902), *Venus athleta* (Conrad), = *Venus latilirata* Conrad, figured by Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1298, pl. 42, fig. 3, 1903; Miocene and Pliocene of the Atlantic coast.

Sculpture of broad concentric waves, attenuated and often conspicuously lamellose distally; radially striate; ligament not covered by the valve margins; the edges of the right nymph and of the left posterior cardinal with interlocking rugosities.

Venus (*Chione*) *latilaminosa* Anderson and Martin,[2] of the lower Miocene of Kern River, belongs to this section. The Recent species are confined to the tropics.

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[1] Univ. Calif. Publ. Geol., Vol. 8, p. 470, pl. 54, fig. 1, 1915.

[2] Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, pp. 59-60, pl. 1, figs. 2*a*, 2*b*, 2*c*, 1914.

Venus (Chione) mariæ d'Orbigny

Venus maria d'Orbigny, Voy. Amér. Mérid., Moll., p. 563, 1846.
Venus cypria Sowerby, Thes. Conch., Vol. 2, p. 722, pl. 157, fig. 113, 1853; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 23, figs. 116*a*, 116*b*, 1863; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 571, 1864.
Chione (Lirophora) mariæ Orbigny, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 395, 1902.
Chione mariæ d'Orbigny, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Shell rather small, trigonal, with high umbones and the posterior extremity prolonged; sculpture of large, reflected, concentric lamellæ and fine radial wrinkles which may be obsolete on some specimens.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Gulf of California, Mexico, to Guayaquil, Ecuador.

This is a handsome species resembling *Venus paphia* Linnæus of the Caribbean region.

Subgenus **MERCENARIA** Schumacher, 1817

Mercenaria Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 45, 135, pl. 10, fig. 3, 1817.

Type (by monotypy), *Mercenaria violacea* Schumacher, *op. cit.*, p. 135, pl. 10, fig. 3, 1817, = *Venus mercenaria* Linnæus, Syst. Nat., Ed. 10, p. 686, 1758; figured by Reeve, Conch. Icon., Vol. 14, pl. 2, figs. 2*a*, 2*b*, 1863; also by Dall, U. S. Nat. Mus., Bull. 37, pl. 55, fig. 7, pl. 71, figs. 1, 3, 1889; etc.; see Schumacher's figure for hinge characters; Recent from Nova Scotia to Mexico; also fossil back to the Miocene.

Shell large, heavy; radial sculpture absent, concentric sculpture of fine sharp growth lamellæ or striæ.

The subgenus *Mercenaria* is represented by the type and several other species in the Tertiary and Quaternary of the Atlantic coast of North America. In the Pacific fauna *V. stimpsoni* Gould, of the Japanese region, is a typical *Mercenaria*. *Venus kennicottii* Dall[1] from Washington is so similar to the Atlantic *V. mercenaria* that the two are very difficult to distinguish; and the fact that it is very rare suggests that it may have been founded on adventitious specimens of the latter. Dall gives its range from Neah Bay, Washington, to Little River, Mendocino County, California.

Genus PAPHIA Bolten, 1798

Paphia Bolten, Mus. Boltenianum, p. 175, 1798; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 362, 1902; Trans. Wagner Inst. Sci., Vol. 3, pp. 1321-1324, 1903; Marwick, Trans. New Zealand Inst., Vol. 57, p. 632, 1927; not *Paphia* Lamarck, 1799, nor 1801, nor Fabricius, 1808, nor Oken, 1815.

Type (by subsequent designation, Dall, 1902), *P. ala-papilionis* Bolten (= *V. rotundata* Gmelin, in part, not Linnæus); figured by Reeve, Conch. Icon., Vol. 14, *Tapes*, pl. 2, fig. 7, 1864; hinge figured by Marwick, Trans. New Zealand Inst., Vol. 57, p. 632, fig. 3*a*, 1927; Indian Ocean.

Shell elongate-ovate, flattened; surface polished and sculptured with rather distant concentric incised grooves; hinge rather narrow, with three cardinal teeth in each valve, the middle cardinal of the left valve and the middle and posterior cardinals of the right valve bifid, a long narrow posterior ridge or nymph in both valves; hinge-plate and teeth smaller than in *Venus*..

Marwick (1927) has shown the differences in the hinges of *Paphia* and *Tapes*,[2] his figures of the hinges being reproduced herewith. The most striking difference shown by *Tapes litteratus*, the type of *Tapes*, is in the very wide middle cardinal of the left valve, which is so deeply bifid that it is almost two teeth, and in the correspondingly wide interspace of the opposing valve. The subgenus *Tapes* Megerle von Mühlfeld is interesting because it shows plainly one method by which the Venerid teeth multiply. The genus *Saxidomus* provides another example of this process.

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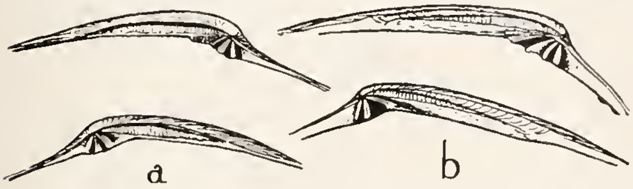
[1] Amer. Journ. Conch., Vol. 7, p. 147, pl. 16, fig. 1, 1871; Proc. U. S. Nat. Mus., Vol. 24, p. 560, pl. 40, fig. 7, 1902; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 155, pl. 14, fig. 7, 1924.

[2] Megerle von Mühlfeld, Mag. Naturf. Freunde zu Berlin für 1811, p. 51, *fide* Dall, 1903.



Text figure 5. Illustration of the hinges of *Paphia* and *Tapes*, from Marwick, Trans. & Proc. New Zealand Institute, Vol. 57, New Issue, text figures 3*a*, 3*b*, 1927; reduced, × ⅔.

a. *Paphia ala-papilionis* Bolten.

b. *Tapes litteratus* (Linnæus).

The fundamental hinge characters of the California species that have been assigned to *Tapes* and *Paphia* are identical with those of *Paphia ala-papilionis* Bolten; but the external sculpture is so different that the California species appear to be more closely related to the true *Venerupis*, under which they are here classed in subgenera. There are now, therefore, no California species of *Paphia* or of *Tapes*.

Genus **VENERUPIS** Lamarck, 1818

Venerupis Lamarck, Hist. Nat. Anim. s. Vert., Vol. 5, p. 506, 1818; Children, Quart. Journ. Sci., Lit., Arts, p. 303 January, 1823.

Pullastra Sowerby, Genera of Shells, Pt. 28, 1826, type (by absolute tautonymy) *Venus pullastra* Montagu.

Type (by subsequent designation, Children, 1823), *Venus perforans* Montagu, Test. Brit., p. 127, pl. 3, fig. 6, 1803, a variety of *Venus pullastra* Montagu.

Shell of moderate size and thickness, ovate-quadrate in outline, sculptured with concentric lines or threads of variable strength and with strong or fine radial striations or ribs; hinge plate narrow, dentition like that of *Paphia;* pallial sinus of variable depth, ascending, rounded at apex.

The recognition of the affinities of *Venus perforans* was taken from Stewart[1] after this catalogue was in galley proof, and the name *Venerupis* was shifted to this group to replace *Marcia*, which was to have been used erroneously, *sensu lato*, with *V. exalbida* as the type, according to Dall's citation. Stewart has pointed out an earlier type designation for *Marcia*, which makes *Marcia* apply to a peculiar smooth-shelled species, more like *Clementia* but heavier and with a different hinge. Stewart has also pointed out that *Irus* antedates *Venerupis* and would have to be used for the forms that have so commonly been called *Venerupis*, no matter what the latter name represents.

Venerupis pullastra is a common, living, European species. It is radially striate and has the *Paphia* hinge; but it appears to be subgenerically distinct from all three of the California groups. The striations are fine and the hinge is weak, leaning toward *Irus*.

Subgenus **HUMILARIA**, new subgenus

Marcia sp., H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 423, Feb., 1857, not the type, *Venus pinguis* Chemnitz, designated by Kobelt, Ill. Conch., Vol. 2, p. 339, 1881; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 360, 1902, type cited, *Venus exalbida* Dillwyn; Trans. Wagner Inst. Sci., Vol. 3, p. 1318, 1903.

Type, Venus kennerleyi Carpenter in Reeve.

Shell rather large, ovate-quadrate, flattened, beaks anterior; sculptured with fine concentric lines and periodic sharp lamellæ but no radial sculpture; pallial sinus rather short, angular, but abruptly rounded at apex; anterior extremity of hinge buttressed just above the anterior adductor scar; valve margins crenulated or smooth.

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[1] Stewart, Special Publication No. 3, Acad. Nat. Sci. Phila., p. 222, 1930.

If Dall's citation of the type of *Marcia* had been the first, the name would be available for this group, even though *Venerupis exalbida* (Dillwyn)[1] does not fit the generic description of *Marcia*, is not like the species that the Adams brothers had chiefly in mind in proposing the name, and is apparently unrelated to most of the species that have since been called *Marcia* by various authors, including Dall himself.

In some respects this subgenus is more closely related to *Mercenaria* than to the radially striate *Venerupis*. It is interesting as a transitional group, intermediate between *Mercenaria* and *Callithaca*. In its sculpture, lunule, and pallial sinus it more closely resembles *Mercenaria;* but its shell is lower (i. e., of lower convexity), thinner, and much more elongate. In shape, in the modification of the dentition caused by the shape, and in the concentric sculpture it very closely resembles *Callithaca;* but it lacks the faint radial sculpture of the latter. *Mercenaria* in the genus *Venus* and *Humilaria* in the genus *Venerupis* are analogous as groups lacking radial striation in genera that are otherwise characterized by it. Perhaps *Mercenaria* should be used as a genus name, with *Humilaria* as a subgenus.

Venerupis (Humilaria) perlaminosa (Conrad)

Mercenaria perlaminosa Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 7, pp. 267, 441, 1855; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 22, pl. 5, fig. 38, 1866, p. 94, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 250, 1888; Arnold, U. S. Geol. Surv., Bull. 321, pp. 32, 76, pl. 12, figs. 1*a*, 1*b*, 1907.

Venus perlaminosa Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 146, 1903; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 81, 1929.

Shell similar to that of *Venerupis exalbida* but with the inner valve margins finely crenulated, the umbones less erect, and the pallial sinus slightly narrower and ascending more rapidly.

Type specimen: In the Academy of Natural Sciences of Philadelphia (?)

Type locality: Near Santa Barbara, California, stated to be Miocene but probably Pliocene.

This species is very similar to *V. exalbida*, only differing in the characters mentioned above. The valve margins are evenly and strongly crenulated, whereas the one specimen of *exalbida* in the Stanford collection shows no sign of crenulations on either valve. The purple color mentioned by Conrad in his description of *perlaminosa* is present on the shell of *exalbida*.

Variety **perlaminosa**, s. s.

Shell with the ventral margin evenly rounded, and the concentric sculpture less differentiated and more closely packed.

Pliocene: Near Santa Barbara (Conrad, as Miocene, see Conrad, p. 441); Bath-house Beach and Packard's Hill, Santa Barbara (Arnold, 1903, 1907); Santa Barbara (Cooper, as Quaternary); Santa Barbara (Gabb, as Post-Pliocene beds on the beach); "Pico" near Ventura (Waterfall).

The typical variety has a proportionally higher shell than the Recent variety, with a more convex, evenly rounded ventral margin. The concentric sculpture of the typical variety often lacks the sharp, erect, distant lamellæ of the Recent form, probably largely or entirely because of weathering. Some worn Recent specimens of the variety *kennerleyi* have the same concentric sculpture.

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[1] *Venus exalbida* Dillwyn, Cat. Shells, p. 170, 1817, as of Chemnitz, Conch. Cab., Vol. 11, pp. 225, 226, pl. 202, fig. 1974, 1795; also figured in Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 4, fig. 13, 1863; southern part of South America, Recent.

Venerupis (Humilaria) perlaminosa (Conrad) variety **kennerleyi** (Carpenter in Reeve)

Venus kennerleyi Carpenter MS., Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 12, fig. 41, June, 1863; not "*Venus kennerlyi* Reeve ?" of Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 22, pl. 5, fig. 37, 1866, = *Clementia (Egesta) pertenuis* (Gabb).

Marcia kennerleyi Carpenter MS., Reeve, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 396, 1902.

Marcia kennerlyi (Carpenter) Reeve, Dall, U. S. Nat. Mus., Bull. 112, p. 42, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 155, pl. 8, fig. 4, 1924.

Shell with the ventral margin less strongly rounded, relatively more elongate, with distant erect concentric lamellæ.

Type locality: Puget Sound; Recent.

Recent: Kodiak Island, Alaska, to Santa Barbara Islands, California (Oldroyd).

The Recent variety is more elongate than the typical variety of *perlaminosa*. The wearing off of the concentric lamellæ produces a coarsely, irregularly undulate chalky surface. The inner margins of the valves are handsomely crenulated, even the margins at the lunule.

Subgenus **CALLITHACA** Dall, 1902

Callithaca Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 364, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1326, 1903.

Type (by original designation), *Tapes tenerrima* Carpenter.

Shell with the shape and hinge characters of the subgenus *Humilaria;* sculpture with the concentric lamellæ of the subgenus *Humilaria*, either distant or closely packed, and with faint radial striations; pallial sinus deep.

This subgenus is like the subgenus *Humilaria* in its shape and concentric sculpture, but it is like *Protothaca* in its pallial sinus and non-crenulated inner margins. It has a much more flattened shell and less conspicuous radial sculpture than *Protothaca*.

Venerupis (Callithaca) tenerrima (Carpenter)

Plate 18, Figures 9*a*, 9*b*

Tapes tenerrima Carpenter, Proc. Zool. Soc. London for 1856, p. 200; Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Gabb, Geol. Surv. Calif. Palæo., Vol. 2, p. 97, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 267, 1888; Keep, West Coast Shells, p. 157, fig. 136, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 151, pl. 14, fig. 6, 1903.

Paphia (Callithaca) tenerrima Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 399, 1902.

Paphia tenerrima Carpenter, Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; U. S. Geol. Surv., Bull. 396, p. 142, pl. 18, fig. 3, Jan. 15, 1910; Bull. 398, pl. 40, same figure, 1910; English, Univ. Calif. Publ. Geol., Vol. 8, pp. 210, 213, 1914; Martin, Vol. 9, p. 253, 1916; Nomland, Vol. 10, p. 219, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 272, pl. 22, figs. 1*a*, 1*b*, 1918; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; Jordan, Vol. 15, p. 244, 1926.

Paphia (Protothaca) tenerrima Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 43, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 156, pl. 30, figs. 1*a*, 1*b*, 1924.

Paphia (Callithaca) tenerrima alta Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 85, pl. 6, fig. 1, 1929.

Shell rather large and flat, chalky, elongate ovate, with small anterior umbones; sculpture of periodically accentuated concentric raised lines and low radial threads; lunule faintly defined, escutcheon not defined; hinge normal, with the left middle cardinal sometimes strongly bifid; pallial sinus very deep, rounded on end. Average specimens about 70 mm. long and 55 mm. high, sometimes much larger.

Type specimens: Of *tenerrima*, in the collection of the Boston Society of Natural History, *fide* Oldroyd; of variety *alta*, in the University of California collection, No. 31,418.

Type localities: Of *tenerrima*, Panama, Recent; of variety *alta*, Hall Canyon, two miles northeast of Ventura, Pleistocene.

Pliocene: Etchegoin of Coalinga region (Arnold); *Chione elsmerensis* zone, lower Pliocene of Coalinga region, common (Nomland); Purisima and Merced formations in the region south of San Francisco; Merced of Sargent oil field, Bolinas Bay, Año Nuevo Bay (Martin); lower Fernando of Elsmere Canyon (Arnold; English) and of Holser Canyon, Los Angeles County (English); Pliocene at Santa Barbara (Cooper).

Pleistocene: Northeast shore of Tomales Bay, Marin County (Dickerson); Santa Barbara (Cooper); Barlow's Ranch, Ventura County (Arnold); Hall and Harmon canyons, Ventura County (Waterfall, as variety *alta*); lower part of Pleistocene section near Santa Paula, Ventura County (U. S. G.); "rather rare" in the upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's, and Deadman Island (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan); etc.

Recent: Puget Sound to San Quintin Bay, Lower California, Mexico (Dall, 1921); Panama (Carpenter).

This species is easily recognized by its chalky white shell, rather evenly ovate, flattened shape, and low but sharp, fine sculpture. It is nearly identical in outline with *Venerupis kennerleyi* (Carpenter MS. in Reeve); but is lighter, flatter, has finer concentric sculpture and also radial striations, and the pallial sinus is much larger than the short, sharply angular sinus of *kennerleyi*. The variety *alta*, described by Waterfall, is based on an unusually high individual; but similar specimens occur living, and the form is probably not of significance. The form *restorationensis* Frizzell[1] of the late Pleistocene near Point Blakeley, Washington, appears to be a northern variety with a heavier shell and coarser radial sculpture. It is also more convex, and its general form shows better the relationship of this species with *V. staminea* than does the typical variety.

Subgenus **PROTOTHACA** Dall, 1902

Protothaca Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 364, Dec., 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1326, 1903.

Type (by original designation), *Chama thaca* Molina, Saggio sulla Storia Naturale del Chile, p. 203, 1782 (+ *Venus dombeii* Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 590, 1818; figured by Reeve, Conch. Icon., Vol. 14, pl. 9, fig. 29, 1863; west coast of South America, Recent.

Shell with the hinge of *Paphia* and of *Venerupis, s. s.*, but with a shorter, more ventricose shape, with more uniform concentric sculpture, and equally strong radial ribs.

It may be possible to substitute older names for *Protothaca* and *Callithaca*, but so much nomenclatorial revision is needed in the *Veneridæ* that it is best to leave such matters for a thorough review at a more opportune time.

Protothaca has the hinge of *Paphia*, but its rough, sculptured surface is very different from the polished and concentrically grooved surface of *Paphia ala-papilionis*. Moreover, the shells of *Protothaca* are heavier, more ventricose, and less elongate.

Venerupis (Protothaca) grata (Say)

Venus grata Say, Amer. Conch., Pt. 3, pl. 26, 1831; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 3, figs. 8*a*, 8*b*, 1863.

Venus histrionica Sowerby, Proc. Zool. Soc. London for 1835, p. 41, June, 1835; Thes. Conch., Vol. 2, p. 714, pl. 155, fig. 52, 1853; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 16, fig. 70, 1863.

Venus fuscolineata Sowerby, Proc. Zool. Soc. London for 1835, p. 41, June, 1835; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 16, fig. 69, 1863.

Venus tricolor Sowerby, Proc. Zool. Soc. London for 1835, p. 41, June, 1835.

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[1] *Paphia restorationensis* Frizzell, Nautilus, Vol. 43, p. 120, April, 1930.

Venus discors Sowerby, Proc. Zool. Soc. London for 1835, p. 42, June, 1835; Thes. Conch., Vol. 2, p. 698, pl. 151, figs. 148-150, 1853; Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 7, figs. 22*a*, 22*b*, 1863.
Venus pectunculoides Valenciennes, Voy. Venus, Atlas Zool., Moll., pl. 16, fig. 3, 1846, *fide* Lamy, 1909; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 203, 278, 1857; Rept. for 1863, p. 528, 1864.
Tapes fusolineata Sowerby, Thes. Conch., Vol. 2, p. 698, pl. 151, fig. 145, 1853.
Tapes grata Say, Sowerby, Thes. Conch., Vol. 2, p. 699, pl. 151, fig. 152, 1853; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 77, 1857; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 155, 1894; Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 75, 1895.
Tapes tricolor Sowerby, Thes. Conch., Vol. 2, p. 699, pl. 151, fig. 153, 1853.
Venus muscaria Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 15, fig. 60, 1863.
Paphia (*Protothaca*) *grata* Say, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 397, 1902.
Venus (*Paphia*) *grata* Say, Lamy, Journ. de Conchyl., Vol. 57, pp. 246, 247, 1909.
Paphia grata Say, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924.

Pleistocene: Lower Quaternary of Magdalena Bay, west coast of Lower California, Mexico (Jordan).
Recent: Turtle Bay, Lower California, Mexico, to Antofagasta, Chile (Jordan).

Color variability has been the principal cause for the overnaming of this handsome species. It is certainly closely related to *V. staminea*, but may possibly be distinguished specifically by its color patterns (which vary greatly) and its shorter pallial sinus. The elements of the hinge are essentially the same, and the sculpture can be matched on specimens of *staminea*. *V. grata* has been reported from San Pedro, and it is possible that it intergrades with *staminea*, in which case the latter should be considered a variety of the earlier described species.

Venerupis (Protothaca) staminea (Conrad)

Plate 18, Figures 1*a*, 1*b*, 2*a*, 2*b*

Venus staminea Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 250, pl. 19, fig. 15, 1837.
Venerupis petitii Deshayes, Rev. Zool. Soc. Cuvierenne, p. 359, 1839; Mag. Zool., Moll., pl. 39, 1841, *fide* Dall, 1921; Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for 1848 and 1849, p. 351, pl. 5, figs. 2*a*-*c*, 1850.[1]
Tapes diversa Sowerby, Thes. Conch., Vol. 2, p. 697, pl. 146, fig. 41, 1853; Conrad, U. S. Pac. R. R. Repts., Vol. 5, pl. 4, figs. 31, 31*a*, 31*b*, 1856.
Venus dispar Gould MS., Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 196, 305, 351, 1857.
Venus ampliata Gould MS., Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 213, 305, 348, 1857.
Venus mundulus Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 14, fig. 51, 1863.
Tapes staminea Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 266, 1888; Keep, West Coast Shells, p. 185, fig. 158, 1888, 1892; Dall, 17th Ann. Rept. U. S. Geol. Survey, Pt. 1, p. 844, 1896; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 150, pl. 14, fig. 4, 1903.
Tapes staminea Conrad, var. *orbella* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864.
? Dosinia staleyi Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 24, pl. 7, fig. 42, 1866.
Tapes staleyi Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 57, pl. 16, figs. 17, 17*a*, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 266, 1888.
Paphia staminea var. *sulculosa* Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 399, pl. 14, fig. 2, 1902.
Paphia (*Protothaca*) *staminea* Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 397, 1902; U. S. Nat. Mus., Bull. 112, p. 43, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 156, pl. 35, figs. 1*a*, 1*b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925.
Paphia staminea var. *orbella* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 398, 1902; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 271, pl. 19, fig. 6, 1918.
Protothaca grewingki Dall, Wash. Acad. Sci., Alaska., Repts. Harriman Alaska Exped., Vol. 4, p. 116, 1904.
Chione staleyi Gabb, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 121, pl. 13, fig. 6, 1909; Amer. Journ. Sci., Ser. 5, Vol. 4, p. 311, 1922.
Paphia (*Tapes*) *statleyi* Gabb, Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 209, pl. 4, figs. 38*a*, 38*b*, 38*c*, 1909.
Paphia staleyi ? Gabb, Arnold, U. S. Geol. Surv., Bull. 396, p. 158, pl. 26, fig. 8, Jan. 15, 1910; Bull. 398, pl. 48, same fig., 1910.

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[1] Eichwald, p. 130, 1871, states that Grewingk's *Venerupis petitii* came from the Cretaceous and renames it *Venus costato-squamosa*. Dall's *grewingki* is therefore a synonym of this form. See the note on *Mya arenaria* variety *profundior*, p. 414.

Paphia staminea Conrad, Thompson, Rept. Brit. Columbia Comm. Fisheries for 1912, pp. 1-38, 1-47, pl. 2, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, pl. 56, fig. 5, 1915; Martin, Vol. 9, p. 253, 1916; Nomland, Vol. 10, p. 219, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 270, pl. 21, figs. 1*a*, 1*b*, pl. 45, 1918; E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 2, p. 2, 1919; Weymouth, Calif. State Fish and Game Comm., Fish Bull. No. 4, pp. 11, 38, pl. 10, fig. 2, 1920; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 563, 1922; E. K. Jordan, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.

Paphia staleyi Gabb, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 593, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916; Nomland, Vol. 10, p. 219, 1917; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922; Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 49, 1926.

Paphia staminea var. *diversa* Sowerby, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

Paphia (*Protothaca*) *staminea petitii* Deshayes, Dall. U. S. Nat. Mus., Bull. 112, p. 43, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 157, 1924.

Paphia (*Protothaca*) *staminea spatiosa* Dall, U. S. Nat. Mus., Bull. 112, p. 43, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 158, pl. 9, fig. 1, 1924.

Paphia (*Protothaca*) *staminea orbella* Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 43, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 157, pl. 33, fig. 6, 1924.

Paphia (*Protothaca*) *staleyi* Gabb, var. *hannibali* Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 98, pl. 10, fig. 1, 1922.

Shell subovate, variable, inflated, beaks anterior; sculpture of radial striæ or ribs and concentric striæ or ridges; hinge normal, as in *Venerupis grata* (Say).

Variety **staminea**, s. s.

Shell with concentric and radial sculpture about equally well developed or with the radial more robust; outline and hinge normal. Size, often between 30 and 50 mm. in length.

Type specimens: Of *staminea*, in the Academy of Natural Sciences, Philadelphia ?; of *hannibali*, No. 58 in the collection at Stanford University.

Type localities: Of *staminea*, California, Recent; of *staleyi*, "from the Pliocene on Mark West Creek, a branch of Russian River, Sonoma County;"of *hannibali*, Pliocene at Scotia, California.

Miocene: "West of San Jose, Santa Clara County; Foxin's, Santa Barbara County" (Cooper); Miocene of St. Paul Island, Pavloff Bay, and Unga Island (Dall, 1896); San Pablo formation, upper Miocene of middle California (Clark; Nomland); Santa Margarita formation, upper Miocene of Coalinga region (Nomland); as *staleyi:* Miocene of Coos Bay, Oregon (Dall); Empire formation of Coos Bay, Oregon (Arnold and Hannibal); Quillayute, Washington (Reagan), probably reworked Empire sandstone.

Pliocene: "Santa Rosa, Sonoma County; Twelve-Mile House, San Mateo County; Kirker's Pass, Contra Costa County [? Pliocene]; Monterey; San Fernando, Los Angeles County" (Cooper); Pacific Beach and Russ School, San Diego (Arnold); lower Merced, San Mateo County (Nomland; etc.; Martin, as var. *diversa*); Etchegoin of Sargent oil field (Martin, also as var. *orbella*); etc.; as *staleyi:* Sonoma County at the type locality (Gabb); Eagle Prairie, Humboldt County; Santa Rosa, Sonoma County; Kirker's Pass, Contra Costa County [Pliocene ?]; Santa Cruz (Cooper); Etchegoin formation at various localities (Arnold; Martin; etc.); middle Wildcat formation of Humboldt County (Martin); Purisima and Merced formations of middle California (Martin; Nomland); Pliocene of Sargent oil field (Nomland); lower Pliocene of Fugler's Point, Santa Barbara County (Carson); etc.; also reported from some of these localities as *hannibali* (Howe).

Pleistocene: "Rare in the lower San Pedro series at Deadman Island, San Pedro" (Arnold); lower San Pedro fauna at Nob Hill cut (Oldroyd); "Saugus" near Ventura (Waterfall); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); east side of Tomales Bay, Marin County (Dickerson); Chiton bed, near San Pedro (Chace); common in upper San Pedro series at and near San Pedro and at Long Beach; Twenty-sixth Street and Spanish Bight, San Diego (Arnold); west side of Point Loma, near Moreno, near Torrey Pines, etc., San Deigo (Stephens); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926); etc.

Recent: Aleutian Islands south to Kamchatka and northern Japan, and to San Quintin Bay, Lower California, and Socorro Island.

Venerupis staminea is an abundant, long-ranging species with many variations and many names, but with only a few varieties worthy of notice. It is even probable that *staminea* is merely a variety of *grata*, in which case *staminea* and its varieties should be treated as varieties under the older name. A very well known synonym is *staleyi* (Gabb), originally described as a *Dosinia* from a specimen without sculpture and with a shape quite different from that of a *Venerupis* of this group. Later Gabb found a better specimen of what he thought was the same species, and figured the hinge (*op. cit.*, pl. 16, fig. 17*a*), which is the hinge of a *Venerupis*. Since then the name has been extensively used for forms, some of which are surely *staminea;* and so far as the present writers know, no one has attempted to show that there is any species distinct from *staminea* to which the name can or should be applied. Howe's variety *hannibali* has a more compressed shape, especially at the posterior end, but it is apparently without significance.

Venerupis (**Protothaca**) **staminea** (Conrad) variety **laciniata** (Carpenter)

Tapes laciniata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 150, pl. 14, fig. 5, 1903.
Paphia staminea var. *laciniata* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 398, 1902.
Paphia (*Protothaca*) *staminea laciniata* Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 43, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 157, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Pleistocene: Upper San Pedro series at San Pedro, "rather rare"; common at Los Cerritos (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Unalaska, Alaska, to San Diego, California (Dall).

The shells which have received this name are large (65 mm. long, 57 mm. high), heavy, and the narrow but prominent ribs are crossed by strong concentric riblets, sometimes spinose at their intersections. This presumed variety may prove to be merely a response to ecologic conditions. Such "varieties" as "*orbella*" are certainly (and generally admittedly) mere reflections of their particular habitat, the globose form of "*orbella*" being due to the confinement of pholad holes. The form called "*spatiosa*" is not distinctive.

It may be necessary to substitute the varietal name *petitii* Deshayes for *laciniata*.

Venerupis (**Protothaca**) **staminea** (Conrad) variety **ruderata** (Deshayes)

Plate 18, Figures 3*a*, 3*b*

Chione ruderata Deshayes, Cat. Conch. Coll. Brit. Mus., Pt. 1, p. 136, 1853.
Venus ruderata Deshayes, Reeve, Conch. Icon., Vol. 14, *Venus*, pl. 25, fig. 130, 1864.
Paphia staminea var. *ruderata* Deshayes, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 398, 1902.
Paphia (*Protothaca*) *staminea ruderata* Deshayes, Dall, U. S. Nat. Mus., Bull. 112, p. 43, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 157, 1924.

Shell sculptured with concentric lines elevated into strong irregular laminæ as in *Venerupis*, leaving the radial sculpture very subordinate; outline made irregular by the burrowing habit, and the hinge becoming narrower and degenerate.

Type specimen: In the British Museum.

Type locality: California; Recent.

Pleistocene: Late Pleistocene terrace along beach southwest of Goleta, Santa Barbara County, localities 40 and 74 (coll. by U. S. G.).
Recent: Southern Bering Sea to Lobitas, California (Dall).

This variety is of considerable interest as it shows a transitional step toward *Irus*. However, the radial riblets, which tend to occur in pairs, have a *Chione* aspect. It is an inhabitant of holes in rocks.

Genus IRUS Oken, 1815

Irus Oken, Lehrbuch Zool., p. 230, 1815.

Type (by absolute tautonymy), *Donax irus* Linnæus, figured by Sowerby in Reeve's Conch. Icon., Vol. 19, *Venerupis*, pl. 4, sp. 22, 1874; living, Great Britain.

Shell of small or medium size and thickness; sculptured with periodically elevated concentric lamellæ, and on the early part of the shell fine radial striations; hinge similar to the hinges of *Paphia* and *Venerupis*, except that the hinge plate is narrower and the teeth usually small and degenerate.

This genus appears to be a specialized derivative of *Venerupis*, modified in characters by the burrowing habit assumed by the animal. It lives in holes burrowed Pholad fashion into soft mudstones, and like *Petricola* may take almost any shape according to the varying hardness of the surrounding material. The variety *ruderata* of *Venerupis staminea* is an independent adaptation of a related Venerid to similar conditions, and shows how close the relation is between *Venerupis* and *Irus*.

There appears to be but one Recent species of *Irus* in the California fauna. It ranges back into the Pleistocene and possibly into the Pliocene. The present authors have a manuscript note referring to a specimen of *Irus foliaceus* (Philippi) from the upper Pleistocene of the coast of Oaxaca, Mexico, collected by R. H. Palmer, but the specimen is at present unavailable for study and the identification is probably wrong. Philippi[1] reported his species from the Red Sea and from Madagascar.

Irus lamellifer (Conrad)

Plate 18, Figures *5a*, *5b*, *6a*, *6b*, 8

Venus lamellifera Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 251, pl. 19, fig. 19, 1837.

Petricola cordieri Deshayes, Rev. Zool. Soc. Cuvierenne, Vol. 2, p. 358, 1839.

Rupellaria lamellifera Conrad, Carpenter, Proc. Zool. Soc. London for 1856, p. 214; Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 262, 1888; Keep, West Coast Shells, p. 183, fig. 156, 1888, 1892.

Venerupis lamellifera Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 400, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1328, 1903; U. S. Nat. Mus., Bull. 112, p. 44, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 160, pl. 39, fig. 8, 1924.

Petricola (*Rupellaria*) *lamellifera* Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 155, 1903.

Variety **lamellifer,** s. s.

Shell variable in shape, moderately heavy, with strong, distant, concentric lamellæ.

Pliocene: Monterey ? (Cooper, as questionably Pliocene).
Pleistocene: Upper San Pedro of Deadman Island, Los Angeles County (Arnold); Santa Barbara (Cooper).
Recent: Monterey to San Diego, California (Dall).

Irus lamellifer (Conrad) variety **prelamellifer,** new variety

Plate 18, Figure 7

Shell like that of the typical variety, but with thinner, more distant lamellæ appearing earlier on the valves, and with perhaps more normally circular shape.

Type specimen: In the collection of the San Diego Society of Natural History, No. 157.

Type locality: Pacific Eastern Production Company's well No. 1, KCL-B, Sec. 21, T. 29 S., R. 27 E., Fruitvale District, Kern County, near Bakersfield, California, depth 4859 feet, upper (possibly middle) Miocene (H. R. G.).

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[1] Abbild. Beschr. Conchyl., Vol. 2, Heft 4, p. 107, *Venus*, pl. 5, fig. 1, August, 1846. "Patria: Mare Rubrum; Madagascar (Petit)."

Miocene: At the type locality, from a well core near Bakersfield, California.

The type specimen of this new variety is a right valve showing the high, thin lamellæ, the fine radial sculpture, and the circular shape. A fragment of the left valve was found with it. From the same well at a depth of 5528 feet there was a specimen of the left valve in a hard matrix but broken so as to show the interior view of the hinge. The middle and anterior cardinals are of the same strength, showing the species to be an *Irus,* not a *Circomphalus.* The shell has much the appearance of *Circumphalus calophylla* (Hanley), living in China.

Species of *Irus* vary so much in character that it is possible that this form is a variation of *I. lamellifer* which had softer material to burrow in, or it may not have burrowed at all. However, the living species appears to have abandoned such habitats, and now burrows in soft or even hard rocks, like the *Pholadidæ.*

Genus CLEMENTIA Gray, 1842

Clementia Gray, Synop. Cont. Brit. Mus., Ed. 44, p. 75, 1842 (genus without species), *fide* Woodring, 1926; Proc. Zool. Soc. London for 1847, p. 184, 1847; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 348, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1234, 1903; Jukes-Browne, Proc. Malac. Soc. London, Vol. 11, p. 85, 1914; Woodring, U. S. Geol. Surv., Prof. Paper 147-C, 1926; Palmer, Palæo. Amer., Vol. 1, p. 409, 1927-29.

Blainvillia Hupé, Rev. Zool., p. 219, 1854, not *Blainvillia* Desvoidy, Mém. Prés. Ac. Roy. Sci. Inst. France, Vol. 2, p. 514, 713, 1830, *Diptera, fide* Dall.

Type (designated by Gray, 1847), *Venus papyracea* Gray, Ann. Philos., New Series, Vol. 9, p. 137, 1825; Wood, Suppl. Index Test., p. 5, pl. 2, fig. 8, 1828; also figured by Palmer, *op. cit.*, text fig. 32 (hinge), and pl. 56, figs. 2, 5, 9, 11, 14, 1927-29; Philippine Islands and East Indies, Recent.

Shell oval or oblong, convex, thin or substantial, sculpture generally concentric and feeble, but sometimes reticulate; lunule indefinite or feebly defined; escutcheon generally depressed, but not defined; valve margins smooth, the right posterior dorsal margin grooved; hinge plate weak or strong in relation to the thickness of the shell, with a concave expansion in front of the teeth; three divergent teeth in each valve, the right posterior being generally bifid or composed of two laminæ; the left posterior a short tooth crossing the hinge plate; pallial sinus variable. Animal having long siphons, united along their whole length, with plain orifices; foot compressed and subquadrate (or hatchet-shaped), like that of *Dosinia;* mantle margins plain. (Jukes-Browne.)

This genus has been discussed by Dall, Jukes-Browne, Woodring, and others. Palmer has recently discussed and figured the Atlantic coast species and refigured the genotype. *Clementia* occurs from the Eocene to the Recent. The living species occur in the tropical and temperate zones.[1]

Subgenus COMPSOMYAX Stewart, 1930

Compsomyax Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 224, 1930.

Type (by original designation) *Saxidomus gibbosus* Gabb = *Clementia subdiaphana* Carpenter.

Shell like that of the typical subgenus but somewhat heavier, the shape more ovate, with lower beaks, and the posterior right cardinal tooth more deeply bifid, the two divisions of this tooth diverging widely.

Typical *Clementia* has a very thin shell and more prominent beaks, and its posterior right cardinal is long and straight, narrowly bifid, consisting of two thin, equal laminæ. The posterior right cardinal of *Compsomyax* consists of two diverging laminæ, the hinder of which is longer than the other. *Flaventia* Jukes-Browne[1] has almost exactly the same distinguishing characteristics, but the writers hesitate to introduce the name from the Cretaceous without a specimen of the type species. *Flaventia* appears to be more ovate, the right anterior cardinals are not so close together, and Jukes-Browne emphasizes the circumscribed lunule. The deeper splitting of the right posterior cardinal in both *Flaventia* and *Compsomyax* may be merely a function of the heavier shells. The subgenus *Egesta* may be still more closely related to typical *Clementia* and might better be considered a section. True *Marcia* appears to be entirely distinct.

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[1] Woodring, *op. cit.*, p. 27, fig. 1, indicates on a map the present range and former distribution of *Clementia, s. s.*, and of *Egesta.*

Clementia (Compsomyax) subdiaphana Carpenter

Plate 17, Figures 10*a*, 10*b*, ? 15

Clementia subdiaphana Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 602, 607, 640, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 56; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 235, 1888; Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 185, pl. 7, figs. 5, 6, 1891.

Callista subdiaphana Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 144, pl. 13, fig. 4, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 544, pl. 49, fig. 3, 1907.

Callista subdiophana Carpenter, var. *pedroana* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 144, pl. 13, fig. 2, 1903.

Marcia subdiaphana Carpenter, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 123, 1909; English, Univ. Calif. Publ. Geol. Vol. 8, p. 210, 1914; Martin, Vol. 9, p. 252, 1916; Dall, U. S. Nat. Mus., Bull. 112, p. 42, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92 and table opp., 1922; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 155, pl. 38, fig. 1, pl. 33, fig. 3, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

"*Marcia oreganensis* Conrad," Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 593, 594, not pp. 583, 584, questionably p. 588, 1913; not *Cytherea oregonensis* Conrad, nor "*Marcia oregonensis*" Dall, 1909, nor Weaver, 1912, etc.

Clementia obliqua Jukes-Browne, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 59, pl. 1, figs. 1, 2, 1913.

Shell of moderate size, sculptured only with fine growth lines, elongate-ovate, varying considerably in outline and ventricosity, beaks anterior to the middle and pointing forward, anterior slope short and abruptly descending, posterior dorsal margin almost parallel for a short distance with the ventral margin, lunule broad and very faintly defined, escutcheon depressed but not defined; hinge like that of *Pitar*, but lacking the anterior left lateral; valve margins smooth, pallial sinus broad and strongly ascending.

Type locality: Puget Sound, Recent.

? Miocene: Possibly in Empire formation ? (Howe, 1922).

Pliocene: Lower Pliocene of Elsmere Canyon (Arnold, 1907) and of Holser Canyon (English), Los Angeles County; Merced and Purisima formations of middle California (Arnold and Hannibal; Martin); San Diego well (Cooper); "Pico" near Ventura (Waterfall); ? Cape Blanco, Oregon.

Pleistocene: "Pliocene" of Deadman Island and Timm's Point (Arnold, 1903); San Pedro to San Diego (Cooper); lower San Pedro series of Deadman Island (Arnold, as variety *pedroana*); "Saugus" near Ventura (Waterfall).

Recent: Sannakh Islands, Alaska, to Santa Barbara Islands and San Pedro, California (Oldroyd).

This species has been confused with "*Marcia oregonensis* Conrad" of Dall, which appears to be a misidentification of *Pitar oregonensis* (Conrad). Some of the above references and occurrences must be considered very doubtful, because of this confusion and the great similarity in the external appearance of this species to forms of *Pitar* occurring in the pre-Pliocene formations.

Large specimens of this species reach a length of 70 mm., a height of 55 mm., and a convexity (of one valve) of 22 mm. The small shells which Arnold named variety *pedroana* are young or stunted specimens.

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[1] Proc. Malac. Soc. London, Vol. 8, p. 167, November 5, 1908, type (by original designation) *Venus ovalis* Sowerby, Cretaceous of England (Blackdown beds), hinge shown by Jukes-Browne, *op. cit.*, pl. 6, fig. 10.

Subgenus **EGESTA** Conrad, 1845

Egesta Conrad, Foss. Tert. Form. United States, p. 70, 1845, reprint, Dall, p. 70, 1893; Woodring, U. S. Geol. Surv., Prof. Paper 147-C, p. 36, 1926.

Type (by monotypy), *Venus inoceriformis* Wagner, Journ. Acad. Nat. Sci. Phila., Vol. 8, pp. 51-52, pl. 1, fig. 1, 1839; also figured by Glenn, Maryland Geol. Surv., Miocene Volume, p. 315, pl. 82, figs. 1, 2, 1904; and by Palmer, Palæo. Amer., Vol. 1, pl. 56, figs. 10, 13, pl. 57, fig. 13*a*, 1929; Maryland, middle Miocene.

According to Woodring, "The larger and heavier shell, flattened or concave upper posterior slope, accompanying truncation of the posterior end, longer and deeper resilium groove, heavier hinge, and narrower pallial sinus separate *Egesta* from *Clementia, s. s.*" The *Inoceramus*-like concentric waves are also conspicuous, at least in most cases.

Clementia (Egesta) pertenuis (Gabb)

Venus kennerlyi Reeve, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 22, pl. 5, fig. 37, 1866; not *V. kennerleyi* Carpenter in Reeve, = *Venerupis perlaminosa* (Conrad).

Venus pertenuis Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 55-56, pl. 5, fig. 37, 1868-9; Branner, Newsom, and Arnold, U. S. Geol. Surv., Folio No. 163, p. 6, 1909; Arnold, U. S. Geol. Surv., Bull. 396, p. 17, pl. 8, fig. 3, 1910; Arnold and Anderson, Bull. 398, pp. 85, 86, pl. 30, fig. 3, 1910; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 174, 1912.

? Venus (Chione) pertenuis Gabb, F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 195, 1905.

Clementia (Egesta) pertenuis Gabb, Woodring, U. S. Geol. Surv., Prof. Paper 147-C, p. 40, pl. 16, figs. 1-6, 1926.

Shell relatively thin, reaching a large size; shape variable, slightly or decidedly elongate, slightly inequilateral, anterior end extended. Lunular area moderately depressed. Sculpture consisting of coarse concentric waves and fine concentric threads. Near the ventral margin the waves are lower and more closely spaced, or they may disappear. Hinge of right valve consisting of a slender anterior cardinal, a heavier middle cardinal, and a long, slender, deeply bifid posterior cardinal; hinge of left valve consisting of a heavy anterior cardinal, a slightly heavier middle cardinal, and a long, thin posterior cardinal. Pallial sinus deep, very narrow, ascending. Holotype: length, 58 mm.; height, 52 mm.; diameter (both valves), 24 mm. (Woodring.)

Type specimen: In the University of California collection, No. 12,000.

Type locality: Griswold's, on the road to New Idria, San Benito County, Temblor Miocene.

Miocene: Vaqueros formation of California (Smith); middle Miocene, *Turritella ocoyana* zone, also Santa Margarita formation, upper Miocene, of a number of localities, in San Benito, Fresno, Kern, San Luis Obispo, Santa Cruz, and Los Angeles counties (*fide* Woodring, 1926).

? Pliocene:[1] Lower part of Purisima formation in Santa Cruz Quadrangle, lower Pliocene (Branner, Newsom, and Arnold).

This species appears to range from the lower Miocene to possibly the lower Pliocene, being rare in the upper limit of its range. Woodring lists all reported occurrences in his paper on *Clementia* referred to above.

Genus **LIOCYMA** Dall, 1870

Liocyma Dall, Proc. Boston Soc. Nat. Hist., Vol. 13, p. 256, 1870; Amer. Journ. Conch., Vol. 7, p. 145, 1871; Fischer, Man. Conchyl., p. 1086, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 364, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1327, 1903.

Type (by original designation), *Venus fluctuosa* Gould.

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[1] In U. S. Geol. Surv. Folio 163 some middle Miocene outcrops were erroneously mapped as Pliocene. In view of this it seems probable that *Clementia pertenuis* (Gabb) is in reality confined to the Miocene formations.

Liocyma fluctuosa (Gould)

Venus fluctuosa Gould, Rep. Comm. Zool. Surv. State Massachusetts, p. 107, 1838, *nomen nudum;* Invert. Mass., p. 87, fig. 5, 1840; Ed. 2 (Binney), p. 136, fig. 447.
Venus astartoides Beck, Middendorff, Mal. Rossica, Pt. 3, p. 56, *fide* Dall, 1870.
Liocyma fluctuosa Gould, Dall, Proc. Boston Soc. Nat. Hist., Vol. 13, p. 256, 1870; Amer. Journ. Conch., Vol. 7, p. 145, 1871; U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 844, 1896 (erroneously as of Beck).

Miocene: Miocene(?) of St. Paul Island, Alaska (Dall, 1896).
Recent: North Atlantic and Arctic oceans.

This small shell is rather flat, with a trigonal shape, and small, irregular concentric rugosities. It is an inhabitant of cold northern waters. Dall reported it in the north Pacific, but omitted it from his catalogue of 1921.

Genus PSEPHIDIA Dall, 1902

Psephis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 56; not *Psephis* Guenée, 1854, *Lepidoptera.*
Psephidia Dall, Journ. Conch., Vol. 10, p. 243, 1902; Proc. U. S. Nat. Mus., Vol. 26, p. 366, Dec., 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1333, 1903; Jukes-Browne, Ann. Mag. Nat. Hist., Ser. 8, Vol. 12, p. 480, 1913.

Type (by subsequent designation, Dall, Dec., 1902), *Psephis lordi* (Baird).

Shell small, trigonal or oval, smooth and polished or concentrically striated; lunule feebly defined but escutcheon not differentiated; hinge with three entire cardinals in each valve and no laterals; pallial sinus small; very fine crenulations present at both extremities of ventral margins of valves. Animal with the mantle edges fused below, the siphons short, simple; an anterior opening for the foot which is not byssiferous.[1]

Jukes-Browne considered this group a subgenus of *Gomphina* Mörch, taking as type for the latter *Venus donacina* Chemnitz.

Psephidia lordi (Baird)

Plate 15, Figures 5, 6, *7a*, *7b*

Chione lordi Baird, Proc. Zool. Soc. London for 1863, p. 69, 1863.
Psephis lordi Baird, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 602, 611, 641, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 261, 1888; Nomland, Univ. Calif. Publ. Geol., Vol. 10, table opp. p. 230, 1917.
Psephidia lordi Baird, Dall, Journ. Conch., Vol. 10, p. 243, 1902; Proc. U. S. Nat. Mus., Vol. 26, pp. 401, 407, pl. 16, fig. 5, 1902; U. S. Nat. Mus., Bull. 112, p. 44, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 161, pl. 6, fig. 3, 1924.

Shell small, of an ovate-triangular shape, a smooth shining appearance, and a light olive color. The surface is concentrically marked with slight grooves. The beaks are prominent and very shining. Internally the surface is white, the margins of the shell very finely crenulate, and the pallial impression short and blunt. (Baird.)

Type specimen: In the British Museum.

Type locality: Esquimalt Harbor, Vancouver Island, British Columbia. The type from the crop of a pin-tail duck.

Pliocene: Upper middle Etchegoin of Coalinga district (Nomland); questionably in the upper Etchegoin of the Southern California Gas Company's well No. 1-4, Kern County, at depths of 2900-3124 feet (H. R. G.).
Pleistocene: Quaternary at Santa Barbara (Cooper).
Recent: Unalaska, Alaska, to Coronado Islands, just off San Diego (Dall, 1921).

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[1] The anatomical characters are as given by Dall, Dec., 1902.

The typical variety of *lordi* is smaller and more trigonal than the variety *ovalis*, according to Dall's figure of Baird's species. The form *barbarensis* Arnold is very smiliar in appearance and may be a synonym; but as no authentic specimens of Arnold's form are available at this time, it is retained until a comparison can be made with Baird's type.

Psephidia lordi (Baird) variety **barbarensis** Arnold

Psephidia barbarensis Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 22, pl. 58, fig. 3, 1907; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916; Waterfall, Vol. 18, pp. 77, 78, 79, 81, 1929.

Type specimen: In the U. S. National Museum, No. 165,238.

Type locality: Bath-house Beach, Santa Barbara; upper Pliocene.

Pliocene: Upper Pliocene at Bath-house Beach, Santa Barbara (Arnold).

According to Arnold, "This species is higher and more trigonal in outline, has a straighter anterior margin, and a less conspicuous tooth than *P. lordii* Baird, which it resembles."

Psephidia lordi (Baird) variety **ovalis** Dall

Psephidia ovalis Dall, Proc. U. S. Nat. Mus., Vol. 26, pp. 401, 407, pl. 16, fig. 4, Dec., 1902; Berry, Nautilus, Vol. 22, p. 38, 1908, questionably as *ovalis;* Dall, U. S. Nat. Mus., Bull. 112, p. 44, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 161, pl. 34, fig. 4, 1924.

Shell small, white, polished, oval, subcompressed; surface with obsolete concentric threads near the anterior base, but over most of the disk smooth; beaks small and very low, at about the anterior third of the length; lunule elongated, extremely narrow, nearly as long as the anterior dorsal slope; escutcheon linear or none; interior white, the pallial sinus moderate, pointed; internal margin delicately striated; hinge well developed, like that of *P. lordi*, with three entire cardinals and no lateral anterior tooth. Length, 8.5; height, 6.5; diameter, 3.0 mm. (Dall, 1902.)

Type specimen: In the U. S. National Museum, No. 163,089.

Type locality: North side of Catalina Island, in 16 fathoms, gravel and sand (Dall.)

Pliocene: Questionably as *ovalis* in the upper Pliocene deposit at Bath-house Beach, Santa Barbara, one valve (Berry).

Recent: St. Paul Island, Bering Sea, to San Diego, California (Dall, 1921).

A pair of valves of this form from San Pedro magnified fourteen times show very fine crenulations at and near both extremities of the ventral valve margins. No tangential grooves were visible, but a single, faint groove on one valve parallel to the growth lines appeared to be oblique at its extremities. The pallial sinus is definite and angular. The hinge is provided with three cardinals in each valve, the left anterior one being directed forward like a lateral.

The variety *ovalis* is more oval and much less trigonal than the typical variety as illustrated in Dall's figure. However, as *lordi* is very variable in shape, this variety, like the others, is of doubtful value.

Psephidia cymata Dall

Psephidia cymata Dall, Proc. U. S. Nat. Mus., Vol. 45, p. 593, June 11, 1913; U. S. Nat. Mus., Bull. 112, p. 44, pl. 3, fig. 2, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 161, pl. 22, fig. 3, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the U. S. National Museum, No. 266,158.

Type locality: Near Cedros Island, Lower California, in shallow water.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Barbara Islands, California, to the Gulf of California (Dall).

This species is distinguished by prominent concentric sculpture.

Psephidia (?) salmonea (Carpenter)

Psephis solmonea Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 261, 1888; Baker, Nautilus, Vol. 16, p. 42, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 152, 1903.

Psephidia salmonea Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 44, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 162, 1924.

Shell small, salmon colored, ovate but with the umbones rather prominent and nearly medial. Size, about 5 mm. in length and 4 mm. in height.

Type specimen: In the British Museum.

Type locality: Farallone Islands, west of San Francisco, California.

Pliocene: Packard's Hill and Bath-house Beach, Santa Barbara (Arnold).
Pleistocene: "Rare in lower San Pedro series at Deadman Island and San Pedro" (Arnold); Santa Barbara (Cooper).
Recent: Farallone Islands to San Diego; also at San Martin Island, Lower California, Mexico (Baker).

Dall (1921) questioned the assignment of this species to the genus *Psephidia*.

Genus TRANSENNELLA Dall, 1883

Transennella Dall, Proc. U. S. Nat. Mus., Vol. 6, pp. 340, 341, 1883; Fischer, Man. Conchyl., p. 1080, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 348, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1240, 1903; Jukes-Browne, Proc. Malac. Soc. London, Vol. 10, p. 345, 1913; Vol. 11, p. 60, 1914; Palmer, Palæo. Amer., Vol. 1, p. 299, fig. 10, 1927.

Type (by monotypy), *Cytherea* (*Transennella ?*) *conradiana* Dall, *op. cit.*, p. 340, 1883; figured by Dall, U. S. Nat. Mus., Bull. 37, Ed. of 1903, pl. 90, fig. 6, 1903, not Dall, Proc. U. S. Nat. Mus., Vol. 24, pl. 31, figs. 5, 7, 1902, *fide* Palmer; also figured in Proc. U. S. Nat. Mus., Vol. 26, pl. 13, fig. 6 [not 5 as stated], and by Palmer, Palæo. Amer., Vol. 1, text fig. 10, and pl. 16, figs. 4, 8, 10, 1927-1929; Pleistocene and Recent of Florida.

Shell small, trigonal, with lively coloration; smooth and polished or concentrically striate; hinge with three cardinals in each valve, the middle left cardinal bifid; an elongate anterior lateral in the left valve, received in a sulcus in the right valve; lunule defined by an incised line, escutcheon not defined; nymphs without rugosities; pallial sinus angular, free below, obliquely ascending; internal margins of the valves sharply tangentially grooved with numerous sulci. (Dall, 1903.)

Geologic range: Miocene to Recent.

This genus differs from *Psephidia* in the presence of an anterior lateral tooth in the left valve. The species listed below is not typical of the genus and probably should be placed in a separate section or subgenus. The type species has strong oblique grooves on the margins of the valves.

Transennella tantilla (Gould)

Plate 15, Figures 8*a*, 8*b*

Venus tantilla Gould, Boston Journ. Nat. Hist., Vol. 6, p. 406, pl. 15, fig. 10, 1853.

Trigonia tantilla Gould, Carpenter, Proc. Zool. Soc. London for 1856, p. 201.

Venus rhysomia Gabb, Proc. Acad. Nat. Sci. Phila. for 1861, p. 371.

Psephis tantilla Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 261, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 153, pl. 13, fig. 5, 1903.

Transennella tantilla Gould, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 384, 1902; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 41, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 150, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pleistocene: "Rather common in the lower San Pedro series at Deadman Island and San Pedro" (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro, "very plentiful" (T. S. Oldroyd); "Saugus" formation near Ventura (Waterfall); Santa Barbara (Gabb; Cooper); Chiton bed at Point Firmin, Los Angeles County (Chace); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan); upper San Pedro series at Deadman Island, Los Cerritos, and San Pedro (Arnold).
Recent: Sitka Harbor, Alaska, south to Lower California, Mexico (Dall, 1921); San Martin Island (Baker).

Type locality: Santa Barbara, California; Recent.

This species has three cardinal teeth in each valve with an anterior left lateral fitting into a socket in the right valve. The inner (lower) margin of this socket is a tooth-like ridge, and it is in line with another small tooth-like ridge that is considered to be the anterior cardinal. There is evidence of one or two oblique grooves on the two extremities of the valve margins, but these grooves are faint and far less clearly developed than those on the valve margins of *T. conradiana*, the type of the genus. This species is not a typical *Transennella* in the character of the valve margins, but it is not known how reliable the grooves are for purposes of classification.

Recent specimens of this species are white, blotched with brown on the posterior fourth of the valves.

Transennella tantilla (Gould) variety **californica** Arnold

Transennella californica Arnold, U. S. Geol. Surv., Bull. 396, p. 72, pl. 26, figs. 7, 7*a*, January 15, 1910; Bull. 398, pl. 48, same figures, 1910.

Type specimen: In the U. S. National Museum, No. 165,553.

Type locality: South end of Kettleman Hills, San Joaquin Valley, California; Pliocene.

Pliocene: Upper part of the Etchegoin formation, upper Pliocene of the type locality (Arnold); Southern California Gas Company's well No. 1-4, Sec. 4, T. 28 S., R. 23 E., Kern County, depth, 3880 feet, probably upper Etchegoin (H. R. G.).

According to Arnold, this shell differs from Recent specimens of *tantilla* in having a "perceptibly shorter and less acute posterior extremity, a more prominent beak, and a more deeply sulcated and more anteriorly located forward cardinal tooth." The type is a well-preserved right valve.

Genus TIVELA Link, 1807

Tivela Link, Beschr. Natur.-Samml. Rostock, Pt. 2, p. 152, 1807; Dall. Proc. U. S. Nat. Mus., Vol. 26, p. 349, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1243, 1903; Jukes-Browne, Proc. Malac. Soc. London, Vol. 10, pp. 266-270, 1913; Woodring, Carnegie Inst., Publ. No. 366, 1925; Palmer, Palæo. Amer., Vol. 1, pp. 315, 316, 1927.

Type (by subsequent designation, Dall, 1902), *Venus corbicula* Gmelin, = *V. mactroides* Born, Index Mus. Cæs. Vindob., p. 53, 1778; Test. Mus. Cæs. Vindob., p. 65, 1780; figured by Palmer, Palæo. Amer., Vol. 1, p. 315, text fig. 16, 1927, pl. 22, figs. 1, 4, 6, 15, 20, 21, 1929; West Indies to Brazil.

Shell porcellanous, smooth, sometimes heavy, trigonal, with prominent beaks and short but stout ligament; hinge with three radiating cardinals in each valve, an anterior lateral in the left valve and a corresponding socket in the right valve, but the teeth variable, sometimes with accessories; pallial sinus distinct, short or long.

This genus is a peculiar derivative of the Venerid family. It is similar in its characters to *Meretrix* and is probably closely related to it. Both may have evolved from some form like *Saxidomus*, the size and position of the teeth being affected by the shape and to some extent by the habitat. It may be possible to trace *Saxidomus* back to some *Paphia*-like form in which the cardinal teeth have multiplied by division and the anterior cardinal has migrated forward to become the anterior lateral. In *Tivela byronensis* (Gray) one cardinal tooth in each valve has split, making four cardinals.

Tivela stultorum (Mawe)

Plate 19, Figures *3a*, *3b*, 8

Donax stultorum Mawe, Linn. Syst. Conch., pp. 37, 40, pl. 9, fig. 7, 1823; Gray, Index Test., Suppl., pl. 2, *Donax*, fig. 2, 1828.

Cytherea (*Trigonella*) *crassatelloides* Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 253, pl. 19, fig. 17, 1837.

Cytherea crassatelloides Conrad, Reeve, Conch. Icon., Vol. 14, *Cytherea*, pl. 1, fig. 3, 1863.

Cytherea (*Tivela*) *crassatelloides* Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 21, pp. 371-378, pls. 23 to 25, 1898; Nautilus, Vol. 13, pp. 73-75, 1899.

Pachydesma crassatelloides Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 96, 1868-9; Cooper, 7th Ann. Rept., Calif. State Mineralogist, p. 256, 1888; Keep, West Coast Shells, p. 189, fig. 162, 1888, 1892.

Tivela (*Pachydesma*) *stultorum* Mawe, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 386, 1902; U. S. Nat. Mus., Bull. 112, p. 41, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 149, 1924.

Tivela crassatelloides Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 143, 1903; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922.

Tivela stultorum Mawe, Jukes-Browne, Proc. Malac. Soc. London, Vol. 10, p. 267, 1913; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 29, pl. 6, figs. 1, 2, 1920; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; I. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 252, 253, 254, 255, 1929.

Shell large, very heavy; teeth heavy, short; valve margins smooth.

Pliocene: Merced formation of Sonoma County (Dickerson).

Pleistocene: "Rare in the lower San Pedro series of Deadman Island" (Arnold); Post-Pliocene at San Diego (Gabb); Santa Barbara to San Diego (Cooper); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan, 1924); "common" in the upper San Pedro series of San Pedro, Los Cerritos, Long Beach, Crawfish George's, and Deadman Island (Arnold); at Twenty-sixth Street and at Spanish Bight, San Diego (Arnold; Stephens); Bay Point, Pacific Beach and Torrey Pines, San Diego (Stephens); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Halfmoon Bay, San Mateo County, to Lower California, Mexico.

This species was figured by Mawe, who attributed it to the "Indian Seas," which must be an error, or else the California shell is not the one he figured and named. It is the "Pismo Clam" of commerce and is highly prized as a shellfish. Its habitat is along exposed sandy beaches, where its heavy shell protects it from the beating of the surf when the shifting of the sand exposes it to wave action. It is able to maintain itself at a rather uniform depth by its stout foot.

Clark has described two species of *Tivela* and a variety[1] from the upper Miocene of California which are similar in general appearance to *T. stultorum*.

Tivela trigonalis Nomland

Tivela trigonalis Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 207, pl. 9, figs. *2a*, *2b*, *2c*, 1916.

Type specimen: In the University of California collection.

Type locality: Near Coalinga; lower Pliocene.

Pliocene: Middle Jacalitos to lower Etchegoin, lower Pliocene of Coalinga district (Nomland).

This is a more inequilateral species than *T. stultorum*, and the type is smaller than fully grown individuals of the latter.

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[1] *Tivela* (*Pachydesma*) *diabloensis* Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 462, 463, pl. 54, figs. 5, 8, pl. 55, fig. 1, 1915; *T.* (*P.*) *diabloensis*, var. *angulatum* Clark, *op. cit.*, pp. 463, 464, pl. 56, fig. 1; and *T.* (*P.*) *gabbi* Clark, *op. cit.*, p. 464, pl. 55, fig. 2, pl. 56, figs. 3, 4, 1915.

Genus SAXIDOMUS Conrad, 1837

Saxidomus Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 249, 1837; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 356, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1280, 1903.

Type (by monotypy), *Saxidomus nuttalli* Conrad, 1837.

Shell large, elongate-ovate and somewhat quadrate, gaping posteriorly, moderately inflated, umbones low; sculptured with concentric lines only, no defined lunule or escutcheon; ligament long, external; hinge with four teeth in each valve, in the right valve the posterior cardinal bifid, the middle cardinal normal, the anterior cardinal with a distal extension which might be considered a lateral, in front of which is another small tooth clearly a lateral, in the left valve the most anterior of the four teeth often considered a lateral, all teeth somewhat variable in development; behind the teeth a small excavated area, and in line with the excavated area a long posterior ridge; pallial sinus deep, broadly rounded on end; valve margins smooth.

Geologic range: Tertiary to Recent, probably from the Oligocene.

Distribution: North Pacific.

This genus looks very much as if it had been derived from a group of Venerids, like some of the Paphias, in which the cardinal teeth have multiplied by division. The distinction between cardinal teeth and lateral teeth appears to be an artificial one, in this case more misleading than helpful. The anterior left lateral of *Saxidomus* is probably of the same origin as the anterior left cardinal of *Paphia;* the two middle teeth of *Saxidomus* are the bifid middle cardinal of *Paphia;* and the posterior cardinals remain the same in each. Similarly, the two little anterior teeth in the right valve of *Saxidomus* seem to be two divisions of the anterior cardinal of *Paphia,* the other teeth in the left valve and the posterior ridges in both valves still corresponding.

Saxidomus nuttalli Conrad

Plate 18, Figure 11

Saxidomus nuttalli Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 249, pl. 19, fig. 12, 1837; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 98, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 263, 1888; Stearns, Nautilus, Vol. 14, pp. 1-3, 1900; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 391, 1902; Baker, Nautilus, Vol. 16, p. 42, 1902; Arnold, U. S. Geol. Surv., Bull. 396, p. 148, pl. 21, fig. 4, January 15, 1910; Bull. 398, pl. 43, same figure, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, 1915; Martin, Vol. 9, p. 253, 1916; Nomland, Vol. 10, pp. 220, 301, 302, 303, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 269, pl. 21, fig. 2, 1918; Weymouth, Calif. State Fish and Game Comm., Fish Bull. No. 4, p. 35, pl. 7, figs. 1, 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 42, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 152, pl. 35, fig. 2, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 255, 1929.

Venus maxima Anton, Philippi, Abbild. Beschr. Conchyl., Vol. 2, Heft 5, *Venus*, p. 151, pl. 2, fig. 1, 1846.

Tapes gracilis Gould, U. S. Pacific R. R. Repts., Vol. 5, p. 333, pl. 19, fig. 20, 1855.

Saxidomus aratus Gould, Otia Conch., p. 168, 1862; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 151, 1903.

Type specimen: In the Academy of Natural Sciences of Philadelphia.

Type locality: "Inhabits the coast of California and Sta. Diego" (Conrad); San Diego (*fide* Oldroyd, 1924).

The above synonymy seems to be beyond dispute. Philippi gave no locality for "*Venus*" *maxima,* but his figure represents Conrad's species. *T. gracilis* and *S. aratus* Gould (+ *S. oratus* Gould) are almost certainly synonyms.

Variety **nuttalli**, s. s.

Shell with conspicuous concentric rugæ.

Miocene: Monterey-Temblor, middle Miocene of California (Nomland); "Martinez; Walnut Creek, Contra Costa County; Santa Cruz; Santa Inez, Santa Barbara County; Santa Monica, Los Angeles County" (Cooper, as *S. gracilis* Gould); upper San Pablo, upper Miocene of middle California (Clark); Santa Margarita formation at its type locality, in the Tejon Hills, and north of Coalinga (Nomland); etc.

Pliocene: Etchegoin of Coalinga region (Arnold; Clark); common in the *Turritella nova* and *Pecten coalingensis* zones of Coalinga region (Nomland); Etchegoin of Sargent oil field; also in the Merced formation of middle California (Martin); "Kirker's Pass, Contra Costa County; Twelve-Mile House, San Mateo County; Santa Barbara; San Fernando, Los Angeles County" (Cooper, as *S. gracilis* Gould); Pico formation near Ventura (Waterfall); etc.

Pleistocene: "Santa Barbara to San Diego" (Cooper); "Rare in lower San Pedro series of Deadman Island;" at Barlow's Ranch, near Ventura (Arnold); "Saugus" formation near Ventura (Waterfall); "not rare" in the lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); lower Quaternary at Magdalena Bay, Lower California, Mexico (E. K. Jordan, 1924); "common in the upper San Pedro series at Deadman Island, Crawfish George's, Los Cerritos, and San Pedro" (Arnold); foot of Twenty-sixth Street, San Diego (Arnold; Mrs. K. Stephens, MS.); Pleistocene shelf at Torrey Pines (F. Stephens); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Humboldt Bay, California, to Lower California, Mexico, San Martin Island (Baker).

This is the southern variety, which is larger and more roughly sculptured than the variety *giganteus* (Deshayes).

Saxidomus nuttalli Conrad variety **giganteus** (Deshayes)

Plate 18, Figures 4, 10

Venerupis gigantea Deshayes, Rev. Zool. Soc. Cuvierenne, Vol. 2, p. 359, Dec., 1839; Magasin de Zool., Moll., pl. 43, 1841.

Saxidomus giganteus Deshayes, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 391, 1902; Thompson, Rept. Brit. Columbia Comm. Fisheries for 1912, pp. I-38, I-47 (as *aratus* by mistake), pl. I, 1913; Arnold and Hannibal, Proc, Amer. Philos. Soc., Vol. 52, pp. 596, 598, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916; Dall, U. S. Nat. Mus., Bull. 112, p. 42, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 153, 1924.

Shell smaller than that of the typical variety, more circular in outline, usually with finer concentric sculpture, which is sometimes periodically accentuated.

Pliocene: Lower part of the Merced formation south of San Francisco (Martin); upper Pliocene of the Elk River formation, Elk River, Port Orford, Oregon (Arnold and Hannibal).

Pleistocene: Saanich formation of Puget Sound and Straits of Georgia (Arnold and Hannibal).

Recent: Aleutian Islands from Attu eastward and south to Monterey, California (Dall, 1921).

This is the cooler water variety of Conrad's species. It varies somewhat in shape and greatly in the thickness of the shell, the individuals living in protected mud bottoms being thin shelled.

From the fossiliferous beds on Popof Island, Alaska, presumed to be of Miocene age, Dall has described[1] *Saxidomus popofianus.* His figure is of a less elongate shell than *S. nuttalli*, with a much shorter pallial sinus. No external shell layer is shown in the figure. A short form, subtriangular, and smaller than *nuttalli* was described by Dall from the Recent fauna of the Admiralty Islands, Alaska, as variety *brevis*[2] of *S. giganteus* (Deshayes).

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[1] Washington Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 115, pl. 10, fig. 4, 1904, reissued by the Smithsonian Institution, 1910.

[2] Proc. U. S. Nat. Mus., Vol. 52, p. 413, no figure, December 27, 1916, type locality, Mole Harbor, Admiralty Islands, Alaska.

Genus MERETRIX Lamarck, 1799

Callista Poli, Test. Utr. Sic., Vol. 1, p. 30, 1791, inconsistently considered not strictly binomial.
Meretrix Lamarck, Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 85, 1799.
Chione Gray, The Analyst, Vol. 8, p. 305, 1838; not *Chione* Megerle von Mühlfeld, 1811, nor of Gray, 1847, nor 1851.
Dione Gray, List. An. Brit. Mus., p. 6, 1851; *fide* Dall, 1903; not *Dione* Gray, 1847, nor *Dione* Hübner, 1816, *Lepidoptera*.
Callista Mörch, Cat. Yoldi, Pt. 2, p. 27, 1853, not of Leach, Syn. Moll. Gt. Brit., p. 302, 1852 (edited by Gray), = *Venus*, *s. s.*, typified by *V. verrucosa;* Palmer, Palæo. Amer., Vol. 1, p. 279, *et seq.*, 1927.

Type (by monotypy), *Venus meretrix* Linnæus; figured by Reeve, Conch. Icon., Vol. 14, *Cytherca*, pl. 3, fig. 10, 1864; Recent, Philippine Islands and China.

Shell of medium to large size, subquadrate to subtrigonal in outline; exterior smooth; hinge with three radiating cardinal teeth in each valve, an anterior lateral in the left, and a corresponding socket bordered by laminæ in the right, in each valve an excavated area behind the beaks; pallial sinus very shallow.

This old genus name applies to a well-characterized group of species, but it does not appear to be appropriate for any of the species represented in this catalogue. See the remarks below on *Megapitaria*.

Genus MACROCALLISTA Meek, 1876

Macrocallista Meek, Rept. U. S. Geol. Surv. Territories, Vol. 9, p. 179, 1876; Tryon, Struct. Syst. Conch., Vol. 3, p. 178, 1884; Fischer, Man. Conchyl., p. 1079, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 351, 1902; Trans. Wagner Inst. Sci., Vol. 3, pp. 1251, 1252, 1903; Palmer, Palæo. Amer., Vol. 1, p. 279, 1927.

Type (by monotypy), *Venus gigantea* Gmelin = *Venus nimbosa* Solander, figured by Reeve, Conch. Icon., Vol. 14, *Dione*, pl. 5, fig. 17, 1863, and by Palmer, Palæo. Amer., Vol. 1, p. 287, fig. 9, pl. 41, fig. 15, pl. 44, figs. 1, 4, pl. 45, fig. 18, 1927; North Carolina south to Cuba and the Gulf coast of the United States, Recent.

Shell elongate-ovate, rather flattened; smooth or sculptured with incised concentric grooves; hinge with two cardinals and a long posterior ridge in each valve, an anterior lateral in the left valve, and a corresponding socket marked off by lamina in the right valve; pallial sinus moderately deep.

This genus is probably closely related to *Pitar*, as pointed out below. There are a number of rather small species in the early Tertiary of the Pacific coast and possibly one in the Pliocene that appear to have the characters of *Macrocallista;* but the species from Lower California assigned to *Macrocallista* have probably been placed there erroneously. The characters of *Macrocallista* recall those of *Paphia*, except that the hinge teeth of the two valves interlock in different order. A study of *Macrocallista* might help to unravel the phylogenetic history of the *Veneridæ*.

Of the species from the Tertiary of California that have been assigned to *Macrocallista* some of the smaller, ovate shells, such as *M. vespertina* (Conrad), may belong to the section *Paradione* Dall.[1]

Macrocallista ? densa Moody

Macrocallista densa Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 58, pl. 2, figs. 1*a*, 1*b*, 1916.

Type specimen: In the University of California collection, No. 11,086.

Type locality: Fourth and Broadway, Los Angeles; Pliocene.

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[1] U. S. Geol. Surv., Prof. Paper 59, p. 120, April 2, 1909, type designated *Cytherea ovalina* Deshayes; new name for *Chionella* Cossmann, Ann. Soc. Roy. Malac. Belg., Ser. 4, Vol. 1, p. 105, 1886; not *Chionella* Swainson, Treat. Malac., p. 335, note, 1840. Marwick (Trans. New Zealand Inst., Vol. 57, p. 592, 1926,) describes the differences between *Macrocallista*, *s. s.*, and *Paradione* Dall, which he believes should be generically separated. *Chionella* Swainson was not used in a generic sense.

Pliocene: Four specimens from the type locality, lower part of the upper Pliocene (Moody).

Moody mentions that this small ovate species possesses "unique characters in the placing of the laterals and in having both posterior cardinals bifid."

Genus PITAR Römer, 1857

Pitar Römer, Krit. Untersuch. Mollesk. Venus, p. 15, 1857; Meek, Rept. U. S. Geol. Surv. Territories, Vol. 9, p. 179, 1876; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 329, 1893; Woodring, Carnegie Inst., Publ. No. 366, p. 152, 1925.

Caryatis Römer. Mal. Blätter, Vol. 9, p. 58, 1862; Stoliczka, Mem. Geol. Surv. India, Cret. Pelecyp. So. India, p. 151, 1871; not *Caryatis* Hübner, 1816, *Lepidoptera.*

"*Pitaria* Römer em.," Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 353, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1264, 1903; Palmer, Palæo. Amer., Vol. 1, p. 216, 1927.

Type (by monotypy), *Venus tumens* Gmelin, figured by Palmer, Palæo. Amer., Vol. 1, p. 216, fig. 2 (hinge); pl. 32, figs. 1, 4, 5, 6, 7, 1927-29, and by Tegland, Univ. Calif. Publ. Geol., Vol. 18, pl. 21, figs. 1-3, 1929; West Africa, the coast of Senegal, and the Gulf of Guinea, Recent.

Shell of moderate size, ovate-subtrigonal, ventricose; sculptured with concentric growth lines; lunule rather wide, defined by an incised line, escutcheon not defined; hinge teeth consisting in the left valve of a large posterior cardinal, a thinner cardinal in front, and an elongate anterior lateral, and in the right valve of a strong posterior cardinal, two other cardinals close together, the anterior very thin, and an anterior socket, in both valves a long posterior ridge corresponding to the posterior ridge of *Paphia* and *Venerupis* and to the broad flattened area of *Venus* and *Dosinia;* pallial sinus pointed, reaching to the middle of the valve; valve margins smooth.

Amiantis Carpenter is closely related, but differs in hinge characters as follows: the left anterior lateral is more elongate, the left posterior cardinal is much more elongate, and the right anterior cardinal is very short, especially in old individuals. The other teeth are of the same general form though much heavier, as is to be expected in the larger, heavier shell of *Amiantis.* In shape the genotypes are similar, though *Amiantis callosa* is less ventricose. It also differs in being heavier and in being prominently sculptured with small concentric ripples. It is probable that *Amiantis* should be classed as a subgenus of *Pitar.*

For notes on the development of the hinge of *Pitar,* see the discussion of *Dosinia.*

Pitar oregonensis (Conrad)

Cytherea oregonensis Conrad, Amer. Journ. Sci., Ser. 2, Vol. 5, p. 432, text fig. 8, 1848, republished by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 150, fig. 8, 1909.

"*Marcia*" *oregonensis* Conrad, of some authors, probably not of Dall, 1909.

? Pitaria clarki Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 7, p. 169, pl. 28, figs. 4*a-e*, 1917.

? Pitaria (*Lamelliconcha*) *coosensis* Weaver and Palmer, Univ. Wash. Publ. Geol., Vol. 1, No. 3, pp. 20, 21, pl. 10, figs. 14, 16, 1922.

Type specimen: Location unknown, probably lost (*fide* Dall, 1909).

Type locality: "Tertiary deposits on the Columbia River near Astoria" (Conrad).

Oligocene or *Miocene* of Astoria, Oregon.

There has been so much confusion between Conrad's *oregonensis* and Carpenter's *Clementia subdiaphana* that it would be useless and misleading to give a long list of references to the literature without a careful examination of all the specimens upon which the records have been based.

From a study of the original description and figure it appears that Conrad's "*Cytherea*" *oregonensis* was based upon a rather small shell with prominent umbones slightly anterior in position but quite unlike the Recent shell upon which Carpenter fixed the name *Clementia subdiaphana* and similarly unlike the shells which Dall unfortunately figured as "*Marcia oregonensis* Conrad." In his original description Conrad remarked that his new species was "remarkably similar to *C. ovata* Rogers, a fossil of the Virginia Miocene, but it lacks the impressed concentric lines of that species." The "*C. ovata* Rogers,"[1] mentioned by Conrad in his comparison, is a typical *Pitar*, in shape nearly identical with Conrad's drawing, and quite unlike *C. subdiaphana* or the figures given by Dall for *Marcia oregonensis*. The figures of *Pitar clarki* (Dickerson), from the Gries Ranch fauna, presumably lower Oligocene of Washington, and those of *Pitar eocenicus* (Weaver and Palmer) of the Cowlitz horizon, upper Eocene of Washington, suggest that possibly these two names may be synonyms of Conrad's *P. oregonensis*. The similarities are striking. Conrad also proposed two other names, *Dione angustifrons* and *D. brevilineata*, in the reports of the U. S. Exploring Expedition. These names apparently apply to similar forms from the Tertiary of the Northwest, forms like Dall's figure of "*Marcia oregonensis*" and like *P. dalli* (Weaver), respectively.

In a recent interesting paper, N. M. Tegland figured and discussed several species of *Pitar* from the Pacific coast Tertiaries, but did not attempt to add to our knowledge of Conrad's early described species. This may have been because *P. oregonensis* was considered a *Marcia*, and the other species are little known. Dall's misidentification of Conrad's species and his absurd assignment of it to the genus *Marcia* (which genus he had himself tried to fix upon a large flattened *Paphia*-like shell) has had much to do with the confusion surrounding this group of species. In passing, it might be remarked that Dall's figures of "*Marcia oregonensis*" are suggestive of Weaver's *Pitar dalli*,[2] from the Washington Oligocene.

Pitar newcombianus (Gabb)

Lioconcha newcombiana Gabb, Proc. Calif. Acad. Sci. for 1865, p. 189; Geol. Surv. Calif., Palæo., Vol. 2, p. 96, 1868-9.

Callista newcombiana Gabb, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 231, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 187, pl. 23, fig. 4, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 143, 1903.

Pitaria newcombiana Gabb, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 387, 1902; U. S. Nat. Mus., Bull. 112, p. 41, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 151, pl. 57, fig. 2, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 251, 1929.

Type specimen: In the University of California collection.

Type locality: Catalina Island, California, in 120 fathoms.

Pliocene: San Diego well, Balboa Park, San Diego (Cooper).

Pleistocene: Rare in the upper San Pedro series at Deadman Island, San Pedro (Arnold); San Diego (Gabb); foot of Twenty-sixth Street, San Diego, abundant (Arnold; Stephens); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to the Gulf of California and Clarion Island, Mexico (Dall, 1921).

This is a plump ovate-trigonal shell with few faint zig-zag brown markings on the exterior of the valves. The left hinge has a strong anterior tooth. It is distinguished from

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[1] Trans. Amer. Philos. Soc., N. S., Vol. 5, p. 340, 1836; Vol. 6, pl. 27, fig. 2, 1839; *Meretrix ovata* Rogers, Clark and Martin, Maryland Geol. Surv., Eocene, p. 168, pl. 34, fig. 1, 1901; *Pitaria* (*Pitaria*) *ovata* (Rogers), Palmer, Palæo. Amer., Vol. 1, p. 219, pl. 4, figs. 3, 4, 20, 1927-9; Eocene of Virginia and Maryland.

[2] *Pitaria dalli* Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 41, pl. 1, figs, 1-4, 1916; discussed and figured by Tegland, Univ. Calif. Publ. Geol., Vol. 18, p. 278, pl. 21, figs, 4-9, 1929.

Clementia subdiaphana when the hinges are not visible by its less elongate shape, by the more nearly central umbones, and by the smoother surface. It is relatively more ventricose and apparently averages smaller than *C. subdiaphana.*

A manuscript note in our possession reports *Pitaria concinna* from the Oaxaca Pleistocene, collected by Palmer, but through some inadvertence the specimen has been misplaced.

Pitar barbarensis (Gabb)

Caryatis barbarensis Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 56, 95, pl. 15, fig. 15*a*, 1868-9.
Pitar barbarensis (Gabb), Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 234, pl. 16, fig. 5, 1930.

Type specimen: In the Museum of Comparative Zoology, Harvard College, No. 15028 (*fide* Stewart).

Type locality: Santa Barbara, "Pliocene."

? Pliocene: At the type locality.

This species is based upon a single specimen, the relationships of which are not known. The specimen appears to be fairly well preserved and may have come from the Pliocene or possibly even from the Pleistocene. It is of somewhat different shape from *P. newcombianus* but may be a distorted form of it.

Subgenus **MEGAPITARIA,** new subgenus

Type, Cytherea aurantiaca Sowerby.

Shell like that of the typical subgenus, with similar hinge, shape, and polished exterior, but very much larger and heavier.

The shells of this group have been assigned by Dall to *Macrocallista;* but although the hinge of *Macrocallista* contains the same elements, modified somewhat by the shape of the shell, the shape is so very different that the two should be separated at least subgenerically. *Macrocallista* is much more elongate, of ovate outline, and much depressed. An early Tertiary group apparently belonging to *Macrocallista* is characterized by incised concentric grooves.

Megapitaria is more closely related to *Pitar* and *Amiantis.* It has the hinge, the shape, the pallial sinus, the heavy shell, and the size of *Amiantis,* from which it can be distinguished only by its smooth surface. The present writers wish to emphasize this relationship with *Amiantis,* which may even be closer than the relationship with *Pitar, s. s.* Perhaps the truest arrangement of all would be to consider *Macrocallista, Megapitaria, Amiantis,* and *Hysteroconcha* all subgenera of *Pitar,* all having the same hinge and being distinguished only by minor differences in shape, size, and sculpture. *Megapitaria* is as distinct as the others.

Lamy has assigned *aurantiaca* and *squalida* to *Meretrix,* which is an older name and has the shape and smooth exterior. However, there appears to be a constant difference between the hinge of *Meretrix* and the hinges of the groups here associated with *Pitar. Meretrix* has three cardinals in the right valve, of about equal strength and about equally spaced. The *Pitar* group has the two anterior cardinals of the right valve smaller and very close together, and in the left valve the anterior cardinal has become very thin to fit between them. *Meretrix* is probably generically distinct. It is interesting that "*Cytherea*" *lyrata* Sowerby has the *Meretrix* hinge and the *Amiantis* sculpture.

Pitar (Megapitaria) aurantiacus (Sowerby)

Cytherea aurantiaca Sowerby, Gen. Rec. Foss. Shells, No. 33, *Cytherea*, fig. 6, 1831; Reeve, Conch. Syst., Vol. 1, p. 94, pl. 69, fig. 3, 1841.
Cytherea aurantia Gray, Analyst, Vol. 8, p. 305, 1838; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 75, 1895.
Cytherea aurantia Hanley, Sowerby, Thes. Conch., Vol. 2, p. 628, pl. 132, fig. 97, 1851.
Dione aurantia Hanley, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 63, 1857.
Dione aurantia Gray, Reeve, Conch. Icon., Vol. 14, *Dione*, pl. 3, fig. 12, 1863.
Cytherea (*Callista*) *aurantia* Hanley, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 153, 1894.
Macrocallista (*Chionella*) *aurantiaca* Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 386, 1902.
Meretrix (*Callista*) *aurantiaca* Sowerby, Lamy, Journ. Conchyl., Vol. 57, p. 242, 1909.
Macrocallista aurantiaca Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 266, 1909; Dall, West American Scientist, Vol. 19, p. 19, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 26, p. 141, 1927.

Pliocene: Santa Antonita Point, Lower California, Mexico (Hanna and Hertlein).
Pleistocene: Lower Quaternary at Magdalena Bay (Jordan), and upper Pleistocene at San Quintin Bay (Dall, 1921), both Lower California, Mexico.
Recent: Gulf of California, Mexico, to Guayaquil, Ecuador (Dall).

Pitar (Megapitaria) squalidus (Sowerby)

Cytherea squalida Sowerby, Proc. Zool. Soc. London for 1835, p. 23, 1835; Gray, Analyst, Vol. 8, p. 306, 1838; Sowerby, Thes. Conch., Vol. 2, p. 629, pl. 131, figs. 87, 88, 89, 1851; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 75, 1895.
Cytherea biradiata Gray, Zool. Beechey's Voy., Moll., p. 151, pl. 43, fig. 5, 1838.
Cytherea chionæa Menke, Zeitschr. f. Malak., Jahrg. 4, p. 190, 1847, *fide* Lamy, 1909.
Dione chionæa Menke, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 64, 1857.
Dione squalida Sowerby, Reeve, Conch. Icon., Vol. 14, *Dione*, pl. 3, fig. 10, 1863.
Cytherea (*Callista*) *chionæa* Menke, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 153, 1894.
Macrocallista (*Chionella*) *squalida* Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 386, 1902.
Meretrix (*Callista*) *squalida* Sowerby, Lamy, Journ. Conchyl., Vol. 57, pp. 241, 242, 1909.
Macrocallista squalida Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 266, 1909; Nautilus, Vol. 32, p. 24, 1918; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 148, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 141, 1927.

Pliocene: Coronados Island, Gulf of California, Mexico (Hanna and Hertlein).
Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Dall, 1918; Jordan, 1924); upper Quaternary at Scammons Lagoon, Lower California, Mexico (Jordan); upper Pleistocene of coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Cedros Island and Scammons Lagoon, Lower California, Mexico, to Peru.

This rather heavy, large shell has an ovate shape, but the umbonal portion is prominent and anterior. It has a shiny, thin periostracum which cracks off when dry, leaving a smooth porcellanous surface of a light creamy or salmon color. The pallial sinus is not deep but very broad and hardly ascending. The valve margins are smooth. In the right valve there are three cardinal teeth; the posterior one is bifid and directed posteriorly and nearly parallel to the long axis of the shell; the middle and anterior are narrow, very close and long. Anterior to the cardinals there is a deep pit for the reception of the left lateral tooth. Below, the margin of the pit is developed into a low lateral tooth. In the left valve there is a strong, prominent lateral tooth, which is probably the anterior cardinal moved forward; the anterior cardinal is a thin wall joined above to the heavy middle cardinal. In the left valve there is no true posterior cardinal (fourth tooth) in this species, but the lower margin of the nymph (which is finely vertically crenulated) projects slightly.

Pitar squalidus is more elongated and pointed at the extremities than *P. aurantiacus*, and the color differs. Mature specimens of *squalidus* average 120 mm. in length and 108 mm. in height, but some are much larger.

Pitar (Megapitaria) orcutti (Dall)

Macrocallista orcutti Dall, Nautilus, Vol. 32, p. 24, July, 1918.

Type specimen: In the U. S. National Museum.

Type locality: Magdalena Bay, Lower California, Mexico; Pleistocene.

Pleistocene: A single imperfect right valve at the type locality (Dall).

This may prove to be a variety or synonym of *P. squalidus.*

Genus AMIANTIS Carpenter, 1864

Amiantis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 526, 640, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 178, March, 1865; Tryon, Struct. Syst. Conch., Vol. 3, p. 178, 1884; Fischer, Man. Conchyl., p. 1079, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 352, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1257, 1903; Jukes-Browne, Proc. Malac. Soc. London, Vol. 11, p. 60, 1913; Palmer, Palæo. Amer., Vol. 1, p. 304, 1927.

Type (by monotypy), *Cytherea callosa* Conrad.

Shell large, heavy, ovate; sculptured with many rounded concentric riblets; lunule defined, escutcheon linear; hinge essentially the same as that of *Pitar;* valve margins smooth.

This genus is closely related to *Pitar* and was probably derived from the same stock in the early Tertiary.

Subgenus **AMIANTIS,** s. s.

Shell heavy but without spines; hinge teeth heavy, except the anterior right cardinal, which is comparatively small; pallial sinus sharp.

Amiantis callosa (Conrad)

Plate 17, Figures 7, 9, 11, 12, 13, 14

Cytherea callosa Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, p. 252, 1837.
Cytherea nobilis Reeve, Proc. Zool. Soc. London, Pt. 17, p. 126, 1850.
Not "*Venus callosa* Conrad," Sowerby, Thes. Conch., Vol. 2, p. 712, pl. 154, figs. 44, 45, 55, 1853.
Dosinia callosa Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 305, 349, 1857.
Dione nobilis Reeve, Conch. Icon., Vol. 14, *Dione*, pl. 4, fig. 15, 1863.
Amiantis callosa Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 526, 640, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 96, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 266, 1888; Keep, West Coast Shells, p. 187, fig. 160, 1888, 1892; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 387, 1902; English, Univ. Calif. Publ. Geol., Vol. 8, p. 209, 1914; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 34, pl. 5, fig. 3, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 41, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 151, pl. 56, figs. 1, 2, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Palmer, Palæo. Amer., Vol. 1, p. 96, 1927, pl. 16, figs. 22, 23, 24, 1929; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.
Callista (*Amiantis*) *callosa* Conrad, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 187, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 145, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 544, pl. 49, fig. 2, 1907.

Type specimen: Of *callosa,* in the Academy of Natural Sciences of Philadelphia ?

Type localities: Of *callosa,* near Santa Barbara, California, Recent; of *nobilis,* California, Recent.

Variety **callosa,** s. s.

Anterior dorsal margin not descending abruptly but extending outward for a short distance almost parallel to the ventral margin, the anterior extremity regularly and strongly curved.

Miocene: Well core near Bakersfield, upper or possibly middle Miocene (H. R. G.).

Pliocene: Lower Pliocene of Elsmere Canyon, Los Angeles County (Arnold, 1907); lower Fernando of Elsmere, Holser, and Pico canyons, but not positively identified (English); lower Pliocene of Elsmere Canyon, locality 207, and of Holser Canyon, locality 217*b*, and middle Pliocene west of Fernando Pass, locality 214, Los Angeles County (H. R. G.).

Pleistocene: "Common in the upper San Pedro series of Los Cerritos," but rare at San Pedro; very abundant at Spanish Bight, San Diego (Arnold, 1903); Bay Point, near Pacific Beach, "few" (Stephens); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Monica (Weymouth) to Gulf of Tehuantepec, Mexico.

This well-known and handsome species is distinguished by its white shell and even, rounded, concentric riblets. It occurs on open beaches just below low tide, and is not often seen unless washed ashore by heavy seas. It occurs only as far north as Los Angeles County, where it is collected alive at Long Beach, Newport, Balboa, and other seaside communities. It may be quite sensitive to temperature conditions, for it is not present in the upper Pliocene and the cold-water Pleistocene faunas.

There is a well-recognized variation in the shape of the valves, most specimens being elongate, while a few are quite rounded. The high form was named *Dione nobilis* Reeve. It is figured by Arnold (1907) from the Elsmere Pliocene. A very similar and certainly closely related species is known in the Tertiary of the Atlantic coast. The Atlantic and Pacific forms probably split from a common stock in the Miocene. Each is so variable in outline that it is probable that the variations overlap. Perhaps one should be recognized as a variety of the other. Also, the living *florida* (Lamarck) is barely distinguishable specifically. It has the hinge, shape, sculpture, lunule, and pallial sinus of *callosa* (according to specimens at the California Institute of Technology).

Amiantis callosa (Conrad) variety **stalderi** (Clark)

Plate 17, Figures *8a*, *8b*

Pitaria stalderi Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 468, pl. 53, figs. 5, 6, Aug. 30, 1915; Nomland, Vol. 10, pp. 301, 302, 1917.
? Antigona willisi Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 152, pl. 5, figs. *2a*, *2b*, May 10, 1922.

Shell like that of the typical variety but with the anterior dorsal extremity descending more abruptly, changing the orientation of the shell, and making the beaks appear higher and more central; sculpture worn or weaker.

Type specimens: In the University of California collection.

Type localities: Of *stalderi*, San Pablo Bay, upper Miocene; of *willisi*, University of California locality 146, upper Miocene.

Miocene: San Pablo and ? Briones formation, upper Miocene, of San Francisco Bay region (Clark; Trask); Santa Margarita formation, upper Miocene, of the Tejon Hills and north of Coalinga (Nomland); well core near Bakersfield, upper or possibly middle Miocene (H. R. G.).

This variety will prove of value if the character of its outline is sufficiently constant to allow identification in the majority of cases. The sculpture is not trustworthy, as it is greatly affected by weathering. *Amiantis dalli* (Clark), also from the upper Miocene of middle California, has a much shorter end and may average larger in size.

"*Antigona willisi*" Trask may be a synonym; but the hinge is not visible in the type specimen, which is not well preserved.

Amiantis dalli Clark

Amiantis (*Amiantis*) *dalli* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 465, pl. 50, fig. 2, pl. 53, figs. 1, 2, 3, 4, August 30, 1915.
Pitaria behri Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 467, pl. 54, figs. 2, 3, 4, 1915.
Amiantis communis Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 305, pl. 14, figs. *2a*, *2b*, *2c*, *2d*, November 8, 1917.

Shell unusually high, with almost circular shape; concentric sculpture somewhat irregular, affected by weathering; hinge coarse, irregular, apparently distorted.

Type specimens: In the University of California collection.

Type localities: Of *dalli* and *behri*, upper Miocene of San Francisco Bay region; of *communis*, upper Miocene northeast of Coalinga.

Miocene: San Pablo group, upper Miocene, east of San Francisco Bay (Clark); Santa Margarita formation northeast of Coalinga (Nomland).

This is an interesting and apparently quite distinct species. There seems to be but one form to take the three names. This form has a much higher and more circular shell than the Recent short specimens of *A. callosa*, which Reeve named *Dione nobilis*.

From the Miocene beds of Kern River and Temblor, F. M. Anderson[1] described "*Venus* (*Callista*) *diabloensis*," which is a high-beaked *Amiantis*, but not so extreme in shape as *dalli*.

Subgenus **HYSTEROCONCHA** Fischer, 1887

Hysteroconcha Fischer, Man. Conchyl., p. 1079, 1887.

Type (by monotypy), *Venus dione* Linnæus; Recent, West Indies.

Shell like that of the typical subgenus, but with a radial row of spines on the posterior part of the valves, and with the hinge teeth smaller, except the anterior right cardinal, which is larger; pallial sinus more rounded.

Amiantis (Hysteroconcha) lupanaria (Lesson)

Cytherea lupanaria Lesson, Centurie Zool., p. 196, pl. 64, 1830; Voy. Coquille, Zool., Vol. 2, Pt. 1, p. 430, 1830; Pfeiffer, in Martini und Chemn. Conch. Cab., Ed. 2, Veneracea, p. 61, pl. 22, fig. 10, 1869. *fide* Lamy, 1909.

Cytherea semilamellosa Gaudichaud, Delessert, Rec. Coq. Lamarck, pl. 19, fig. 2, 1841; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 520, 1864.

Cytherea lupinaria Lesson, Sowerby, Thes. Conch., Vol. 2, p. 632, pl. 132, fig. 111, 1851.

Dione lupanaria Lesson, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 67, 1857

Dione semilamellosa Gaudichaud, Reeve, Conch. Icon., Vol. 14, *Dione*, pl. 6, figs. 20*a*, 20*b*, 1863.

"*Venus radiata* Perry," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 520, 1864; not of Perry, Conch., pl. 58, *Venus*, fig. 2, "New Zealand," 1811.

Pitaria (*Hysteroconcha*) *lupanaria* Lesson, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 388, 1902; Vol. 37, p. 267, 1909.

Meretrix (*Pitaria*) *lupanaria* Lesson, Lamy, Journ. Conchyl., Vol. 57, p. 243, 1909.

Pleistocene: Oaxaca, Mexico (R. H. Palmer, coll.).
Recent: Ballenas Lagoon, Lower California, Mexico, to Paita, Peru (Dall, 1909).

This is a handsome shell with long spines, like *A. dione* (Linnæus), but larger.

Genus **DOSINIA** Scopoli, 1777

Dosinia Scopoli, Intr. Hist. Nat., p. 399, 1777; Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 346, 1902; Trans. Wagner Inst. Sci., Vol. 3, p. 1226, 1903; Jukes-Browne, Proc. Malac. Soc. London, Vol. 10, p. 95, 1912; Vol. 11, p. 63, 1914; Palmer, Palæo. Amer., Vol. 1, p. 268, 1927.

Type (by monotypy), *Chama dosin* Adanson, Hist. Nat. Senegal, pl. 16, fig. 5, in text "Le Dosin," p. 225, 1757, "côte de Portudal," = *Dosinia africana* Hanley, figured by Palmer, Palæo. Amer., Vol. 1, text fig. 6 of hinge, also pl. 48, figs. 5, 8, 13, 14, 1927-1929; west coast of Africa, Recent.

Shell of circular outline and low convexity, ranging from small to large and heavy; surface polished, sculptured with somewhat distant, incised, concentric grooves; lunule impressed, escutcheon linear or obsolete; hinge plate rather broad, with a flat, platform-like area in each valve behind the teeth, in each valve just posterior to and under the beaks and anterior to the ligament a small area excavated out of this platform, on the anterior edge of the platform in each valve a ridge set off so that it resembles a cardinal tooth, in the left valve anterior to this ridge two more cardinals, the posterior stout, the anterior thin (in the type widely diverging), and in addition a more or less well-developed anterior lateral, in the right valve three cardinals in front of the ridge, the posterior bifid, the anterior thin and close to the medial as in *Pitar;* pallial sinus distinct, V-shaped, generally strongly ascending; valve margins smooth.

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[1] Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 196, pl. 17, figs. 83-85, 1905.

Geologic range: In North America, Eocene to Recent; in Europe, Miocene to Recent; in New Zealand, from Eocene (possibly Cretaceous) to Recent.

For a discussion of the sections of this genus, the reader is referred to the literature cited above, particularly to the valuable papers by Jukes-Browne.

The phylogenetic history of this genus promises to be very interesting when thoroughly worked out. An example of the development of the hinge is noted below in the discussion of *Dosinia ponderosa* variety *longidens.* It appears to the present writers that the relationships between *Dosinia* and the other Venerids are much more significant than the differences, and that therefore it would be a mistake to separate this genus into a different subfamily. As has already been pointed out by Jukes-Browne or by Cossmann (the reference is not available at the present moment), *Dosinia* and *Pitar* (the latter in the past often called *Callista*) converge in the early Tertiary. If the *Veneridæ* are to be divided into subfamilies, *Dosinia* and *Pitar* should be placed together. However, *Venus* is not so far removed as the current practice of overemphasizing the distinction between the anterior cardinal tooth and the anterior lateral has led us to suppose. Because *Dosinia* has the shape more of *Venus* than of *Pitar*, it is easier to compare its hinge with that of *Venus.*

The relation between *Venus* and *Dosinia* is similar to that between *Clementia* and *Pitar.* In the right valve the hinge elements are almost identical, except that in *Dosinia* and *Pitar* the anterior and middle cardinals are closer together than in *Venus* and *Clementia.* In the left valve the middle bifid cardinal of *Venus, Paphia, Venerupis,* and *Clementia* has in *Dosinia* and *Pitar* apparently split more deeply, becoming two cardinals, and the anterior cardinal has swung around to a position parallel with the shell margin, becoming an anterior lateral. The difference has the appearance of being fundamental because intergradations between the two arrangements are mechanically impossible. The arrangements involve a different order of interlocking of the anterior teeth. In the *Venus* arrangement, the most anterior tooth is in the right valve and in some cases is close to and parallel to the shell margin, like a lateral; whereas, in the *Dosinia* arrangement, the middle cardinal of the right valve fits between the split parts of the middle cardinal of the left, and the anterior cardinal of the right valve takes its place behind the anterior tooth of the left, which is then free to swing around next to the shell margin. The change must therefore be made in one jump; and if this is true, different branches of the family may have made the same change independently. For the time being, until the phylogeny of the *Veneridæ* is better known, it seems premature to divide the family into subfamilies on this basis.

Dosinia ponderosa (Gray)

Plate 15, Figures 1*a*, 1*b*, 1*c*

Artemis ponderosa Gray, Analyst, Vol. 8, p. 309, 1838; Reeve, Conch. Icon., Vol. 6, *Artemis*, pl. 1, fig. 4, 1850; Sowerby, Thes. Conch., Vol. 2, p. 656, pl. 140, fig. 2, 1852.

Cytherea (*Artemis*) *gigantea* Sowerby, Philippi, Abbild. Beschr. Conch., Vol. 2, Heft 8, *Cytherea*, p. 231, pl. 7, figs. 1*a*, 1*b*, April, 1847, not *Cytherea gigantea* Gmelin, Sowerby, Thes. Conch., Vol. 2, p. 628, pl. 131, fig. 86, 1851.

Venus cycloides d'Orbigny, Voy. Amér. Mérid., Moll., p. 562, 1847; *fide* Lamy.

? *Artemis distans* Sowerby, Thes. Conch., Vol. 2, p. 657, pl. 140, fig. 3, 1851.

Dosinia ponderosa Gray, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 60, 1857; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 97, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 239, 1888, in part only; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 154, 1894; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 75, 1895; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 146, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 543, pl. 46, fig. 4, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Martin, Vol. 9, p. 252, 1916; Nomland, Vol. 10, p. 299, 1917; Dall, Nautilus, Vol. 32, p. 24, 1918; U. S. Nat. Mus., Bull. 112, p. 41, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 149, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Dosinia (*Dosinidia*) *ponderosa* Gray, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 384, 1902.

Shell large, heavy, more circular in outline than most species of *Dosinia*.

Type specimen: In the British Museum.

Type locality: Gulf of California.

Variety **ponderosa**, s. s.

Beaks rather low, lunule deeply impressed so that it makes nearly a right angle with the protruding anterior dorsal margin, no flattened area along the posterior dorsal margin; anterior lateral tooth of the left valve reduced to a small, rounded tubercle.

Pleistocene: Upper Pleistocene at foot of Twenty-sixth Street, San Diego (Arnold; Stephens); upper Pleistocene of San Quintin Bay (Jordan), and Pleistocene of Magdalena Bay, Lower California, Mexico (Dall, 1918).

Recent: San Diego, California, south to Paita, Peru (Dall, 1921).

Although the characters of this variety (the typical) sound quite definite on paper, they are really not well defined, and it is difficult to classify specimens that depart from the typical form in one or more of the distinguishing characters. There is room for difference of opinion about the degree of distinction between the forms here considered. If each form did not vary so, it would be easier to decide whether it is a variety or a distinct species. The separation of the other varieties from *ponderosa*, *s. s.*, recalls the separations made above between *Venus elsmerensis* and *V. gnidia* and between *Amiantis callosa*, *s. s.*, and the variety *stalderi*.

Dosinia ponderosa (Gray) variety **jacalitosana** Arnold

Plate 15, Figures 2*a*, 2*b*, 3

Dosinia jacalitosana Arnold, U. S. Geol. Surv., Bull. 396, p. 67, pl. 16, fig. 5, January 15, 1910; Bull. 398, pl. 38, same figure, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 219, pl. 10, figs. 1, 1*a*, 1917; Hoots, Bull. 812-D, U. S. Geol. Surv., p. 284, 1930.

Dosinia arnoldi Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 459, pl. 51, figs. 1, 2, Aug. 30, 1915; Nomland, Vol.10, pp. 300, 302, 1917.

Dosinia (*Dosinella*) *merriami* Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 460, 461, pl. 49, figs. 1, 2, pl. 52, figs. 1, 2, Aug. 30, 1915.

Shell like that of the typical variety but with more prominent beaks, a less impressed lunule, more descending anterior dorsal margin, and a beveled or flattened area along the posterior dorsal margin; anterior lateral tooth of the left valve larger and not regularly rounded.

Type specimens: Of *jacalitosana*, in the U. S. National Museum, No. 165,575; of *arnoldi* and *merriami*, in the University of California collection.

Type localities: Of *jacalitosana*, fourteen miles southwest of Coalinga, lower Pliocene; of *arnoldi*, south side of Mount Diablo, upper San Pablo group, upper Miocene (also in Santa Margarita beds north of Coalinga); of *merriami*, Kirker's Pass to the north of Mt. Diablo, upper Miocene.

Miocene: Base of San Pablo group at Kirker's Pass, north of Mt. Diablo, and lower San Pablo of San Pablo Bay, upper Miocene (Clark, as *D. merriami*); upper San Pablo group, south side of Mt. Diablo, also Santa Margarita beds to the north of Coalinga (Clark, as *arnoldi*); Santa Margarita north of Coalinga, and questionably San Pablo of the Tejon Hills (Nomland, as *arnoldi*); Kirker's Pass, Contra Costa County (Cooper, as *ponderosa*); etc.

Pliocene: Jacalitos of Coalinga region (Arnold; Nomland); Etchegoin of the southeastern end of the San Joaquin basin (Hoots); *Dosinia* beds of Balboa Park, San Diego (Hertlein and Grant); S. D. S. N. H. localities 228, 263, etc., between Pico Canyon and Fernando Pass, Los Angeles County, common; etc.

A study of the variations of the Pliocene *Dosinia* shows that the upper Miocene forms described by Clark as *merriami* and *arnoldi* fall well within the limits of variation of the Pliocene form. It is unfortunate that Arnold's type is poorly preserved, not showing the hinge, and worn so as to give an erroneous impression of its length. However, a reconstruction of its shape is a help, and Nomland has figured a better specimen from Arnold's locality. Nothing else is known that Arnold could have had. Weathering accounts for the appearance of the surface of *merriami*, sometimes producing the same effect on Pliocene specimens.

Dosinia ponderosa (Gray) variety **occidentalis** Clark

Dosinia merriami variety *occidentalis* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 462, pl. 50, fig. 1, 1915; Nomland, Vol. 10, p. 300, 1917.

Dosinia merriami variety *diabloensis* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 460, 1915, error for *occidentalis*.

Shell like that of the variety *jacalitosana*, but with abnormally high beaks.

Type specimen: In the University of California collection.

Type locality: Presumably south side of Mount Diablo, upper Miocene.

U. Miocene: Type locality (Clark; Nomland).

This variety is a peculiar form. It recalls in shape *Dosinia margaritana* Wiedey[1] of the lower Miocene.

Dosinia ponderosa (Gray) variety **longidens**, new variety

Plate 15, Figure 4

? Unnamed cast, Conrad, U. S. Pac. R. R. Survey, Reports, Vol. 5, pl. 4, fig. 32, 1856, reprinted by Blake, with explanation of plates indicating that the casts figured probably belong to *Dosinia* sp., New York, 1858.

? "*Dosinia ponderosa* Gray," Arnold, U. S. Geol. Surv., Bull. 396, pp. 17, 21, 124, pl. 9, fig. 1, January 15, 1910; Bull. 398, pl. 31, same figure, 1910.

Shell like that of the variety *jacalitosana* in shape but distinguished by the anterior lateral tooth of the left valve which is elongated parallel to the shell margin.

Type specimen: No. 146 in the collection of the San Diego Society of Natural History.

Type locality: Well core of the Superior Oil Company's well, Ansolabehere No. 1, in Sec. 9, T. 29 S., R. 27 E., Mt. Diablo Base and Meridian, northwest of Bakersfield; horizon, upper (possibly middle) Miocene.

Miocene: Middle Miocene, Temblor formation, of Barker's Ranch, Kern County (specimen in the collection at Stanford University); ? *Turritella* bed on east flank of high hill northeast of Oil City, Coalinga district (Arnold, 1910, as *D. ponderosa*); at the type locality (see above; H. R. G.).

One or more of a number of older names proposed by Conrad, Gabb, Wiedey, and possibly others may be applicable to this form; but as yet the hinge characters of these older-named forms are not known, and it is impossible to tell yet which, if any, of them can be used here. Photographs of Conrad's three Miocene species are given on plate 22, figures 1, 3, 4. For the time being, therefore, the writers wish to call attention to the character of the anterior lateral tooth by naming the variety *longidens*.

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[1] Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 145, pl. 18, figs. 1, 2, March 31, 1928.

The evolution of the anterior lateral tooth in *Dosinia ponderosa* is interesting. In the oldest variety, variety *longidens*, it is elongated like the anterior lateral of *Pitar* and other probably related genera. Except that it is more distant from the beaks, it is not unlike the right anterior cardinal of forms like *Venerupis staminea* variety *ruderata* (see plate 18, figure 3*a*). In the variety *jacalitosana* it has shrunk to a rounded mass; and in the living variety it has become a mere tubercle.

Dosinia dunkeri (Philippi)

Cytherea dunkeri Philippi, Abbild. Beschr. Conch., Vol. 1, Heft 7, *Cytherea*, p. 4, pl. 2, fig. 5, 1844.

Cytherea pacifica M. Berol., *fide* Philippi, *op. cit.*, not *Venus pacifica* Dillwyn, Descr. Cat. Rec. Shells, Vol. 1, pp. 175, 176, 1817 (= *Venus chinensis* Chemnitz, Neues Syst. Conch. Cab., Vol. 11, p. 227, pl. 202, fig. 1976, 1795, not Chemnitz, Vol. 10, p. 356, pl. 171, fig. 1663, 1788).

? *Artemis simplex* Hanley, Proc. Zool. Soc. London for 1845, p. 11, 1845; Cat. Rec. Biv. Shells, p. 357, pl. 15, fig. 41, 1842-56; Reeve, Conch. Icon., Vol. 6, *Artemis*, pl. 10, fig. 59, 1850; Sowerby, Thes. Conch., Vol. 2, p. 657, pl. 140, fig. 6, 1852.

Artemis dunkeri Philippi, Reeve, Conch. Icon., Vol. 6, *Artemis*, pl. 6, fig. 41, 1850; Sowerby, Thes. Conch., Vol. 2, p. 657, pl. 140, fig. 5, 1852.

Dosinia dunkeri Philippi, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 61, 1857; Römer, Monog. *Dosinia*, p. 17, pl. 3, fig. 3, 1862; Lamy, Journ. Conchyl., Vol. 57, p. 240, 1909; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 265, 1909; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 465, 1926.

Dosinia (*Dosinidia*) *dunkeri* Philippi, Dall, Proc. U. S. Nat. Mus., Vol. 26, p. 384, 1902.

Shell smaller than that of *D. ponderosa*, with higher, more prominent beaks.

Pliocene: Imperial formation of Carrizo Creek region, western Imperial County (Hanna).
Recent: Gulf of California, Mexico, south to Tumbes, Peru, and the Galapagos Islands.

The shape of this species recalls *Dosinia mathewsonii* Gabb, of the Miocene. The pallial sinus of *dunkeri* is strongly ascending, the lower margin being almost vertical. *D. simplex* appears to be based on a shell with a slightly higher umbo, but it is not sufficiently distinct to warrant a separate name.

Dosinia bunkeri Hanna,[1] from the La Jolla Eocene, has a Dosinoid shape, but a very thin shell and the hinge is unknown. It may not be a *Dosinia*. *Dosinia ? alaskana* Dall,[2] from the Tertiary beds of Popof Island, Alaska, is a high form that is questionably referred to *Dosinia*, as the hinge is unknown. A number of other Pacific coast Tertiary Dosinias have been named, but need not be discussed here.

Family PETRICOLIDAE

Shell elongate to subglobose, variable in shape on account of the habit of boring in clay or soft rock; hinge narrow, generally with two cardinal teeth and posterior nymph; valves gaping at both ends; pallial sinus deep.

Genus PETRICOLA Lamarck, 1801

Petricola Lamarck, Syst. Anim. s. Vert., p. 121, 1801; Children, Quart. Journ. Sci., Lit., and Arts, p. 303, 1823; Gray, Proc. Zool. Soc. London for 1847, p. 184, 1847; Herrmannsen, Indicis Gen. Malac., Vol. 2, pp. 240-242, 1847; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 444, 1893; Jukes-Browne, Proc. Malac. Soc. London, Vol. 9, pp. 214, 215, 1910.

Rupellaria Fleuriau de Bellevue, Journ. Physique, Vol. 54, p. 3, 1802.

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[1] Univ. Calif. Publ. Geol., Vol. 16, p. 287, pl. 42, figs. 4, 6, 1927.

[2] Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 115, pl. 10, fig. 7, 1904, reissued by Smithsonian Inst., 1910. Deposits on north shore of Popof Island supposed to be of Miocene age.

Type (by subsequent designation, Gray, 1847), *Venus lithophagus* Retzius, Mém. Acad. Roy. Turin, Vol. 3, pp. 11-14, figs. 1, 2, 1786, + *Rupellaria striata* and *R. reticulata* F. de Bellevue, *op. cit.*, p. 3, 1802, *fide* Bucquoy, Dautzenberg, and Dollfus, *op. cit.*, p. 445, pl. 67, figs. 20-28, 1893; also figured in Reeve, Conch. Icon., Vol. 19, *Petricola*, pl. 2, figs. 11*a*, 11*b*, 1874; Mediterranean, and coasts of England, France and Spain.

Petricola carditoides (Conrad)

Plate 13, Figures 14*a*, 14*b*

Saxicava carditoides Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 255, pl. 20, fig. 8, 1837.

Saxicava californica Conrad, *op. cit.*, p. 256, pl. 20, fig. 9, 1837.

? *Petricola arcuata* Deshayes, Rev. Zool. Soc. Couv., Vol. 2, p. 358, 1839, *fide* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 835, 1898.

? *Saxicava legumen* Deshayes, Rev. Zool. Soc. Couv., Vol. 2, p. 358, 1839, *fide* Dall, *op. cit.*, p. 835, 1898.

Saxicava abrupta Conrad, U. S. House of Representatives, Document No. 129, p. 13, July, 1855, reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 166, 1909; Conrad, U. S. Pacific R. R. Repts., Vol. 5, p. 324, pl. 3, figs. 25, 25*a*, 1856.

Petricola pedroana Conrad, U. S. House of Representatives, Document No. 129, p. 13, July, 1855, reprinted by Dall, *op. cit.*, p. 166, 1909; Conrad, U. S. Pacific R. R. Repts., Vol. 5, p. 324, pl. 3, fig. 24, 1856.

Petricola carditoides Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 526, 528, etc., 1864; reprinted in Smithsonian Miscellaneous Collections No. 252, 1872; Cooper, 7th Annual Rept. Calif. State Mineralogist, p. 258, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 154, 1903; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 124, 1909; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 220, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 44, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 163, pl. 34, figs. 6*a*, 6*b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Shell of medium size, extremely variable in shape, rather ventricose, varying from globular or short and subquadrate to elongate; umbones anterior, small, turned in and adjacent; valves gaping slightly at both ends; sculpture consisting of fine radiating threads and irregularly developed concentric growth lines and lamellæ; hinge with two oblique cardinal teeth in each valve, stronger on the right valve, the anterior cardinal of which is somewhat cuneiform and incipiently bipartite; ligament external, on a nymph posterior to the cardinal teeth; pallial sinus distinct, deep; adductor scars nearly equal in size. Dimensions quite variable: Elongate forms often about 35 mm. long and 17 mm. high; subquadrate forms about 35 mm. long and 28 mm. high.

Type specimens: Of *Saxicava abrupta* Conrad, in the U. S. National Museum, No. 1,869; location of the others not known to the present authors.

Type localities: Of *S. carditoides*, Santa Barbara, Recent; of *S. californica*, near Santa Barbara and San Diego; of *S. abrupta* and *pedroana*, San Pedro, Recent.

Pliocene: Rare in *Pecten coalingensis* zone, upper Etchegoin formation, near Coalinga (Nomland).

Pleistocene: Lower San Pedro series at Deadman Island (Arnold); lower San Pedro of Nob Hill cut, "plentiful" (T. S. Oldroyd); "Saugus" formation near Ventura (Waterfall); upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, and San Pedro; also Pleistocene at Spanish Bight, San Diego (Arnold).

Recent: Vancouver Island, British Columbia, to Magdalena Bay, Lower California, Mexico (Dall, 1921).

This species is exceedingly variable in shape because of its habit of living in holes in rocks or inside of dead shells. It varies from elongate to subovate, and occasional specimens are globular. The sculpture serves to distinguish it from *denticulata* Sowerby. *P. carditoides* has very fine, closely and rather evenly spaced, radiating threads, while *denticulata* has larger, more widely spaced, and more continuous, radiating riblets, which increase in size and distance apart near the anterior end. Clark has described a *Petricola* from the upper Miocene, which should probably be referred here.[1]

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[1] *Petricola buwaldi* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 471, pl. 60, fig. 6, 1915, based apparently upon a specimen that lived inside of a ribbed shell.

Section Petricolaria Stoliczka, 1871

Petricolaria Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 139, 1871; Tryon, Struct. Syst. Conch., Vol. 3, p. 174, pl. 112, fig. 94, 1884.

Type (by subsequent designation, Tryon, 1884), *P. pholadiformis* Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 505, 1818, figured by Tryon, also by Reeve, Conch. Icon., Vol. 29, *Petricola*, pl. 1, fig. 7, 1874.

Shell elongate, subcylindric anteriorly, laterally flattened posteriorly; sculpture of radial riblets coarser anteriorly; valves with slight gape at both ends.

Geologic range: Tertiary to Recent.

Distribution: Shores of North and South America; Ceylon; etc.

The species belonging to this section are elongate, and the sculpture is generally coarser than on shells of the typical section. Petricolarias have stronger, larger, and wider-spaced ribs on the anterior portions of the valves, where the ribs are often frilled with growth lamellæ.

Petricola pholadiformis Lamarck

Petricola pholadiformis Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 505, 1818; Deshayes and Milne Edwards Edition (Ed. 2), Vol. 6, p. 159, 1835; Reeve, Conch. Icon., Vol. 19, *Petricola*, pl. 1, fig. 7, 1874; Dall, U. S. Nat. Mus., Bull. 37, p. 58, pl. 59, fig. 15, pl. 64, fig. 140*a*, 1889.

Petricola cognata C. B. Adams, Ann. New York Lyc. Nat. Hist., Vol. 5, p. 510, 1852; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 363, 1857; Rept. for 1863, p. 552, 1864; Proc. Zool. Soc. London for 1863, p. 367, 1863.

Petricola (*Petricolaria*) *cognata* C. B. Adams, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 156, 1903.

Shell elongate, beaks near anterior end; sculpture of radiating ribs, very fine on posterior half of shell, coarse and widely spaced on anterior portion.

Pleistocene: Rare in the upper San Pedro series at the lumber yard at San Pedro and at Deadman Island (Arnold).

Recent: North Atlantic (as *P. pholadiformis*); Panama and north, perhaps to California (generally as *cognata*).

As there seems to be no significant difference between the Pacific and Atlantic specimens the older name is here used. There are specimens in the Stanford collection from Scammons Lagoon, Lower California, from Monterey, and from the mud-flats off Redwood City in San Francisco Bay. The California specimens might have been introduced. Carpenter considered the Atlantic and Pacific forms identical.

This species is more regularly elongate and has coarser anterior ribs than *P denticulata*.

Petricola denticulata Sowerby

Petricola denticulata Sowerby, Proc. Zool. Soc. London for 1834, p. 46, Sept., 1834; Thes. Conch., Vol. 2, *Petricola*, p. 773, pl. 166, figs. 6, 7, 1854; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 244, 297, 1857; Reeve, Conch. Icon., Vol. 19, *Petricola*, pl. 2, figs. 9*a*, 9*b*, Nov., 1874; Dall, Nautilus, Vol. 13, pp. 121, 122, 1900; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 163, 1924.

Petricola tenuis Sowerby, 1834, C. B. Adams, and others, in part, *fide* Dall, 1900.

Petricola nivea Sowerby, Proc. Zool. Soc. London for 1834, p. 34, 1834; Thes. Conch., Vol. 2, *Petricola*, p. 773, pl. 166, figs. 13, 14, 1854.

Psephis tellimyalis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 641, 1864; Journ. Conchyl., Vol. 12, p. 135, 1865, larval shell, *fide* Dall, 1900.[1]

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[1] Since this went to press, Mr. George Willett of the Los Angeles Museum has shown the writers specimens of *Petricola tellimyalis* (Carpenter) and also young specimens of *P. denticulata* of the same size. It is clear that the two are distinct species. Carpenter's species is much more trigonal in shape than the young of *denticulata*. It is also more brownish, and the largest specimens attain a length of only about a quarter of an inch. The type is in the U. S. National Museum. In 1865 Carpenter said on the authority of J. Rowell, the collector, that it came from California.

Cypricardia pedroana Conrad, Cooper, Calif. State Mining Bureau, Bull. 4, p. 25, 1894.
Petricola (*Petricolaria*) *denticulata* Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 155, 1903.
Petricolaria denticulata Sowerby, Dall, U. S. Nat. Mus., Bull. 112, p. 44, 1921.

Shell elongate, ventricose, with radial sculpture, the radial riblets larger and more widely spaced on the anterior portion of the valves.

Type locality: Payta, Peru; Recent.

Pliocene: In the city of Los Angeles (Williamson, *fide* Cooper).
Pleistocene: "Rare in the upper San Pedro series at the lumber yard at San Pedro and at Deadman Island" (Arnold).

The synonymy of this species is probably confused with that of *carditoides*. *P. denticulata* is variable in shape, but it can be distinguished from *carditoides* by its stronger, more continuous radial riblets.

Superfamily TELLINACEA

Siphons distinct to their bases, usually long; pallial line sinuate; ligament external, seated on nymphs; hinge normally with an anterior and a posterior lateral in each valve, two radial cardinals, of which the anterior is usually bifid and somewhat pedunculated, and the posterior, as well as the laterals, often obsolete. (Dall.)

Family TELLINIDAE

Shell substance cellulo-crystalline, with an inconspicuous epidermis; valves slightly unequal, free, rounded in front, more or less rostrate, oblique and gaping behind, compressed, usually with smooth margins, low beaks, and variable, chiefly concentric sculpture; anterior adductor scar larger, frequently irregular; pedal distinct; one or two isolated small scars made by attachments of the muscles of the mantle frequently visible near the ventral posterior termination of the pallial sinus; resilium embraced in the ligament, subexternal; cardinal area narrow, small, covered with a dark epidermis, or frequently obsolete; hinge plate narrow, anterior lamina approximate, posterior more distant from the cardinals, when present; cardinal teeth small. (Dall.)

Genus TELLINA Linnæus, 1758

Tellina Linnæus, Syst. Nat., Ed. 10, p. 674, 1758; Ed. 12, p. 1116, 1767; Gmelin, Syst. Nat., p. 3228, 1792; Children, Quart. Jour. Sci., Lit., and Arts, p. 306, January, 1823; Gray, Proc. Zool. Soc. London, Pt. 15, p. 186, 1847, Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 116, 1871; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 289, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1004, 1900; Woodring, Carnegie Inst., Publ. No. 366, p. 166, 1925.
? *Angulus* Megerle von Mühlfeldt, Mag. Gesellsch. Naturf. Freunde zu Berlin, Vol. 5, p. 47, 1811.
"*Tellinella* Gray, 1852" Mörch, Cat. Conch. Yoldi, Pt. 2, p. 13, 1853; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 394, 1856; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 116, 1871.
Eutellina Fischer, Man. de Conchyl., p. 1147, 1887.
Liotellina Fischer, *op. cit.*, p. 1147, 1887.

Type (by subsequent designation, Children, 1823), *Tellina radiata* Linnæus; Recent, West Indies.

Shell elongate, of low convexity, posterior sometimes rostrated or twisted; two lateral teeth in each valve; shell substance porcellanous.

Geologic range: Jurassic to Recent.

Distribution: World wide.

The sections of this genus have not been critically revised.

Section TELLINA, s. s.

Shell moderately large, with sculpture consisting primarily of growth lines; posterior end somewhat rostrated, with a shallow depression extending from near the posterior margin toward the umbo; right posterior and left anterior cardinals bifid; lateral laminæ present, less prominent in the left valve; pallial sinus deep, U-shaped at end, lower margin confluent with pallial line.

Tellina idæ Dall

Plate 20, Figures 12, 14*a*, 14*b*

Tellina idæ Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 183, pl. 6, fig. 3, pl. 7, figs. 1, 4, 1891; Williamson, Vol. 15, p. 185, 1892; Cooper, Calif. State Mining Bureau, Bull. 4, p. 32, 1894; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 301, pl. 4, figs. 10, 11, 1900; Arnold, Vol. 32, p. 527, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Dall, Bull. 112, U. S. Nat. Mus., p. 45, 1921; Dall in Orcutt, West American Scientist, Vol. 19, No. 2, p. 19, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 164, pl. 14, fig. 4, 1924.
Tellina (*Angulus*) *idæ* Dall, Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 158, 159, pl. 15, fig. 6 (not fig. 7), 1903.
Tellina nevadensis Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 61, pl. 2, figs. 32-*c*, 1914.
? *Tellina englishi* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 472, pl. 61, figures 6, 7, 1915.

Shell ovate-triangular; posterior dorsal slope straight, obliquely truncate at the end, the posterior extremity rostrated by a narrow, shallow, radial depression just anterior to the rostral ridge; right valve with a deeply impressed line just in advance of the posterior dorsal margin; sculpture of definite, concentric, rather evenly spaced, fine incremental lamellæ.

Type specimen: In the U. S. National Museum.

Type locality: Long Beach, Los Angeles County; Recent.

Miocene: "Lower Miocene" (probably Temblor) of Kern River and of San Luis Obispo County (Anderson and Martin, as *nevadensis*); San Pablo, upper Miocene (Clark, as *englishi*); (upper ?) Miocene of Superior Oil Company's well, Ansolabehere No. 1, near Bakersfield, depth 4575 feet (H. R. G.).

Pliocene: Lower Fernando at Elsmere Canyon, Los Angeles County (Arnold, 1907; English, 1914); "Miocene" of San Diego (Dall, 1891); loc. 214 S. D. S. N. H., middle Pliocene west of Fernando Pass, Los Angeles County (H. R. G.).

Pleistocene: Nob Hill cut, San Pedro, California (Oldroyd Collection at Stanford University); upper San Pedro series of Los Cerritos, Los Angeles County, very rare, "one valve" (Arnold, 1903); upper Pleistocene of San Quintin Bay, west coast of Lower California, Mexico (Dall in Orcutt, 1921).

Recent: Santa Barbara Islands, Catalina, and San Pedro, California.

Tellina nevadensis Anderson and Martin, from the "lower Miocene" (probably Temblor) of Kern River and of San Luis Obispo County, appears to be of the same species as specimens of *T. idæ* from Nob Hill, San Pedro, in the Oldroyd Collection at Stanford University. *T. englishi* Clark is considerably more elongate, but variations in specimens show that this feature is probably without significance.

This very distinct species is not at all common. The concentric lines are stronger, sharper, and more distant on the right valve than on the left.

Tellina aragonia Dall

Tellina aragonia Dall, Prof. Paper 59, U. S. Geol. Surv., pp. 18, 124, 125, pl. 14, fig. 3, 1909; Arnold, U. S. Geol. Surv., Bull. 396, pp. 26, 134, pl. 14, fig. 2, Jan. 15, 1910; Bull. 398, pl. 36, same figure, 1910; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922.

Type specimen: In the U. S. National Museum, Catalogue No. 153,940.

Type locality: Coos Bay, Oregon; upper Miocene.

Miocene: Empire formation, Coos Bay, Oregon (Dall; Howe).
Pliocene: Jacalitos formation, Coalinga district, California (Arnold).

This species is well figured by Arnold. It appears to be closely related to *Tellina santarosæ* Dall,[1] a Recent species of a slightly more elongate shape. It is broadly and bluntly rostrated, the posterior dorsal margin being curved, not straight as in *T. idæ*. It may not belong to this section.

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[1] Proc. U. S. Nat. Mus., Vol. 23, p. 321, pl. 3, fig. 6, pl. 4, figs. 1, 2, 1900.

Section MOERELLA Fischer, 1887

Moerella Fischer, Man. de Conchyl., p. 1147, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 291, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1014, 1900; Woodring, Carnegie Inst., Publ. No. 366, p. 166, 1925.

Type (by monotypy), *Tellina donacina* Linnæus; Recent, seas of Europe.

Shell medium-sized, inflated, elongate-ovate, inequilateral, posterior end obscurely rostrate; sculpture consisting of concentric rugæ; right anterior and left posterior cardinals very small; right laterals strong, anterior one closer to cardinals; left laterals weaker, anterior one weaker than posterior; pallial sinus almost touching anterior adductor scar, confluent with pallial line, its apex U-shaped. (Woodring.)

Moerella is close to *Tellina*, *s. s.*, but has a weaker left anterior lateral tooth and the rostration is more obscure. According to Dall, *Moera* Adams, 1856, not Leach, 1815; *Mæra* Adams, 1856, not Leach, 1813; and *Donacilla* Gray, 1851, not Lamarck, 1812, are synonyms.

Tellina salmonea (Carpenter)

Mæra salmonea Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 423, 1864.

Tellina (*Moerella*) *salmonea* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 302, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 157, pl. 13, fig. 7, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 45, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 165, pl. 44, figs. 3*a-b*, 1924; T .S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 6, 1925.

Tellina salmonea Carpenter, Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, 1915.

Type locality: Vancouver Island, British Columbia; Recent.

Miocene: Upper and lower parts of the San Pablo formation, middle California (Clark).

Pleistocene: Lower San Pedro series of Deadman Island, "not uncommon" (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd).

Recent: Aleutian Islands to San Pedro, California (Dall, 1921).

Tellina meropsis Dall

Plate 14, Figures 9*a*, 9*b;* Plate 20, Figures 9*a*, 9*b*

"*Tellina gouldi* Hanley" of Carpenter and of some Pacific coast collectors; not of Hanley.

Tellina (*Moerella*) *meropsis* Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 317, pl. 3, fig. 1, November, 1900; Bull. 112, U. S. Nat. Mus., p. 45, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 166, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Tellina meropsis Dall, Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, no. 16, pp. 250, 253, 1929.

Type specimen: In the U. S. National Museum, Cat. No. 123,410.

Type locality: San Diego, California; Recent.

Pleistocene: "Saugus" formation, near Ventura (Waterfall); near International Boundary Monument No. 258, also at northeast corner of Mission Bay, San Diego County (Frank Stephens).

Recent: San Diego, California, to the Gulf of California, Mexico (Dall, 1921).

Specimens in the Oldroyd Collection at Stanford University labeled *Tellina meropsis* Dall appear to be the same as other shells labeled *T. reclusa* Dall. We have not seen the type specimens of either species and retain them with misgivings in the separate sections where they were placed by their author.

Section MERISCA Dall, 1900

Merisca Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 290, November 14, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1012, December, 1900; Woodring, Carnegie Inst., Publ. No. 366, p. 171, 1925.

Type (by original designation), *Tellina crystallina* Wood, General Conch., p. 149, 1815; Recent, West Indies and Pacific coast of Central America; figured by Dall, Proc. U. S. Nat. Mus., Vol. 23, pp. 311, 312, pl. 2, fig. 10, 1900.

Shell small or of moderate size, trigonal-ovate, moderately convex, posterior end rostrated, with basal margin emarginate in front of rostrum; sculpture consisting of distant, thin concentric lamellæ and sometimes fine radial lines; pallial sinus deep, confluent with pallial line; hinge with strong laterals in the right valve, but without laterals in the left valve.

The strong right lateral teeth and the absence of left laterals distinguish this section from *Tellina*, *s. s.*

Tellina reclusa Dall

Tellina (*Merisca*) *reclusa* Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 315, pl. 3, fig. 2, 1900; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924.

Type specimen: In the U. S. National Museum, Cat. No. 105,513.

Type locality: San Ignacio Lagoon, Lower California, Mexico; Recent.

Pleistocene: Upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).
Recent: San Ignacio Lagoon, west coast of Lower California, to Gulf of California, Mexico (Dall).

This species resembles *T. meropsis*, but appears to have a posterior sulcus on the left valve which is lacking or obscure on the left valve of *meropsis*. Dall figures opposite valves of the two species.

Section EURYTELLINA Fischer, 1887

Eurytellina Fischer, Man. Conchyl., p. 1147, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 290, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1013, 1900; Woodring, Carnegie Inst., Publ. No. 366, pp. 167, 168, 1925.

Type (by monotypy), *Tellina punicea* Born, Testacea Musei Cæsarei Vindobonensis, p. 33, pl. 2, fig. 8, 1780; Recent, Pacific coast of northern South America.

Shell medium-sized, elongate-ovate, subequilateral; posterior end not rostrate but with a narrow flattened area; sculpture consisting of concentric rugæ; right anterior cardinal relatively heavy, right laterals strong, anterior lateral close to the cardinals, posterior lateral distant; left posterior cardinal small and very slender, left laterals not so strong as the right, resembling them in position; pallial sinus touching anterior adductor, wholly confluent with pallial line. (Woodring.)

The lack of rostration and the characters of the hinge are sufficient to distinguish this section from the other groups of this genus. According to Woodring, it is extensively represented in Tertiary and Recent faunas.

Tellina rubescens Hanley

Tellina rubescens Hanley, Proc. Zool. Soc. London for 1844, p. 60, 1844; Sowerby, Thes. Conch., Vol. 1, *Tellina*, p. 242, pl. 50, fig. 153, 1846; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 270, 1909; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Tellina simulans C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., Vol. 5, p. 508, 1852; Römer, in Martini und Chemnitz, Conch. Cab., Ed. 2, Tellinidæ, p. 99, pl. 25, figs. 4, 5, 1871; Bertin, Nouv. Archiv. Mus. Paris, Ser. 2, Vol. 1, p. 259, 1878.

"*Tellina punicea* Born," Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 35, 1857, not of von Born, 1780; Reeve, Conch. Icon., Vol. 17, *Tellina*, pl. 12, fig. 53, 1866; *fide* Lamy, 1909.

Tellina (*Eurytellina*) *rubescens* Hanley, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 302, 1900; Lamy, Journ. de Conchyl., Vol. 57, p. 251, 1909.

Tellina (*Angulus*) *rubescens* Hanley, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 159, pl. 15, fig. 8 (not fig. 9 as given), 1903.

Pleistocene: Lower Quaternary of Magdalena Bay, west coast of Lower California, Mexico (Jordan); "rare in upper San Pedro series of San Pedro" (Arnold).
Recent: Scammons Lagoon, Lower California, Mexico, to Tumbez, Peru.

This species has very little evidence of posterior rostration, the anterior and posterior margins being greatly dissimilar in general aspect. It reaches a length of 40 or 50 millimeters.

Tellina oregonensis Conrad,[1] from the Miocene of Oregon and Washington, may belong to this section. Some of its supposed occurrences may be of Oligocene age.

Section ANGULUS Megerle, 1811

Angulus Megerle von Mühlfeldt, Mag. Gesellsch. Naturf. Freunde zu Berlin, Vol. 5, p. 47, 1811; Gray, Proc. Zool. Soc. London, Pt. 15, p. 186, 1847; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 291, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1014, 1900.

Type (by subsequent designation, Gray, 1847), *Tellina lanceolata* Linnæus.

Size generally small, elongate, posterior end pointed but not twisted, sculptured with fine concentric lamellæ or normal growth lines, or smooth; hinge with a single strong right anterior lateral tooth, which is closely adjacent to the cardinals, other laterals absent.

Geologic range: Eocene to Recent (Dall, 1900).

Tellina carpenteri Dall

Angulus variegatus Carpenter, Brit. Assn. Adv. Sci., Report for 1863, pp. 611, 627, 639, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, pp. 423, 424, Dec., 1864; not *Tellina variegata* Gmelin, 1792.

Tellina (*Angulus*) *carpenteri* Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 303, 1900; Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 421, 1908; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 166, pl. 44, figs. 10*a*-*b*, pl. 29, fig. 2, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925.

Tellina carpenteri Dall, Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 276, pl. 25, fig. 10, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type locality: Neah Bay; Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); lower Quaternary of Magdalena Bay, Lower California (Jordan, 1924); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Forrester Island, Alaska, to Gulf of California, Mexico (Dall, 1921); Panama (Dall, 1908).

Tellina modesta (Carpenter)

Angulus modestus Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 602, 639, 681, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 54; Dall, Bull. 112, U. S. Nat. Mus., p. 45, 1921.

Tellina (*Angulus*) *modesta* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 304, 1900; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 167, 1924.

Tellina modesta Carpenter, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924.

Pleistocene: Upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).

Recent: Vancouver Island, British Columbia, to Lower California, Mexico (Dall, 1921).

Section OUDARDIA Monterosato, 1884

Oudardia Monterosato, Nomencl. Gen. Spec. Conch. Medit., p. 22, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 291, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1014, 1900.

Type (by original designation), *Tellina oudardii* Payraudeau, Cat. Annel. Moll. l'Ile de Corse, p. 40, pl. 1, figs 16-18, 1826 = *Tellina compressa* Brocchi, Conch. foss. Subapp., p. 514, pl. 12, fig. 9, 1814, *fide* Monterosato, 1884.

With a thick internal anterior rib. (Dall.)

Tellina buttoni Dall

? *Tellina pedroana* Conrad, U. S. Pacific R. R. Repts., Vol. 5, p. 323, pl. 3, fig. 17, 1855.

? *Macoma pedroana* Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 94, 124, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 248, 1888.

Angulus ? var. *obtusus* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864, not *Tellina obtusa* Sowerby, Min. Conch., Vol. 2, p. 175, pl. 179, fig. 4, 1818.

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[1] Amer. Jour. Sci., Ser. 2, Vol. 5, p. 432, fig. 5, 1848, reproduced by Dall, Prof. Paper 59 U. S. Geol. Surv., p. 150, fig. 5, 1909.

Tellina (Angulus) var. *obtusus* Carpenter, Proc. Acad. Nat. Sci. Phila., p. 56, 1865, not *Tellina obtusa* Sowerby, 1818.
"*Angulus modestus* Carpenter" of some early California collectors, not of Carpenter, 1864.
Tellina (Oudardia) buttoni Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 304, pl. 4, figs. 12, 13, November 14, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1036, pl. 47, fig. 18, December, 1900; U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 167, pl. 44, figs. 7*a-b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.
Tellina (Angulus) buttoni Dall, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 157, pl. 15, figs. 2 and 9, 1903, not pl. 16, figs. 1 and 2.
Tellina buttoni Dall, Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 252, 1929.

Type specimen: In the U. S. National Museum, No. 42,865*a*.

Type locality: Guadalupe Island, Lower California, Mexico; Recent.

Pleistocene: Lower San Pedro of Deadman Island and San Pedro bluffs (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); Pleistocene at Barlow's Ranch, near Ventura (Arnold); "Saugus" near Ventura (Waterfall); Pleistocene of San Diego (Dall, 1900); Pleistocene of Spanish Bight, San Diego (Stephens); upper San Pedro of Deadman Island, San Pedro, Crawfish George's, and Los Cerritos (Arnold); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Lituya Bay, Alaska, to the Gulf of California, Mexico (Dall, 1921).

Section Peronidia Dall, 1900

Peronidia Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 291, November 14, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1014, December, 1900.

Type (by original designation), *Tellina albicans* Gmelin.

Shell without laterals, having the internal characters of *Angulus*, *s. s.*, and the external characters of *Eurytellina* Fischer. (Dall.)

Tellina bodegensis Hinds

Plate 20, Figure 13

Tellina bodegensis Hinds, Zoology Voy. Sulphur, Mollusca, p. 67, pl. 21, fig. 2, 1844; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 267, 1888; Keep, West Coast Shells, p. 197, fig. 169, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 185, 1892; Dall, Vol. 23, p. 320, pl. 4, figs. 12, 13, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1029, 1900; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 254, 1916; Nomland, Vol. 10, table opp. p. 230, 1917; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 42, pl. 11, fig. 1, 1920; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 251, 1929.
Tellina (Angulus) bodegensis Hinds, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 158, pl. 15, fig. 7 (not fig. 8), 1903.
Tellina (Peronidia) bodegensis Hinds, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 304, 1900; U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 168, pl. 44, fig. 5, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: Bodegas Bay, California; Recent.

? Miocene: Oregon; Walnut Creek, Contra Costa County (Cooper).
Pliocene: Etchegoin formation, *Chione elsmerensis* zone, of Coalinga region (Nomland); lower Merced formation near San Francisco, and middle Wildcat formation of northern California (Martin).
Pleistocene: San Pedro to San Diego (Cooper); lower San Pedro series of Deadman Island and San Pedro; Pleistocene at Spanish Bight, San Diego (Arnold); lower San Pedro fauna of Nob Hill cut at San Pedro (T. S. Oldroyd), "Saugus" formation near Ventura (Waterfall); near International Boundary Monument No. 258, San Diego County (Stephens); lower Quaternary of Magdalena Bay, Lower California, Mexico (Jordan, 1924); upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, Deadman Island, and Long Beach, common (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).
Recent: Queen Charlotte Islands, British Columbia, to Gulf of California, Mexico; questionably Japan (Dall, 1921).

Tellina lutea Gray

Tellina lutea Gray, Index Testac., Suppl., pl. 1, fig. 3*c*, 1828, *fide* Dall, 1900; Grewingk, Russisch-Kaiserliche Mineralogische Gesell. zu St.-Petersburg, Verhandlungen for the years 1848 and 1849, p. 359, 1850; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 219, 221, 301, 1857; Rept. for 1863, p. 9, 1864; not "*Tellina lutea* Gray," Krause, Archiv. f. Naturg. for 1885, p. 37.

Tellina alternidentata Broderip and Sowerby, Zool. Journ., Vol. 4, pt. 15, p. 363, 1829 (possibly October, 1828); Sowerby, Zool. Voy. Blossom (Captain Beechey's Voy.), p. 153, pl. 44, fig. 5, 1839; Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896.

Tellina guildfordiæ Gray, in Griffith's Cuvier, Vol. 12, pl. 19, fig. 2, 1834, *fide* Dall, 1900.

? *Tellina venulosa* Schrenck, Bull. Acad. Imp. Sci., p. 411, 1861; Reise in Amurl., Moll., p. 556, pl. 22, figs. 2-5, 1867, *fide* Dall, 1900.

Tellina (*Peronidia*) *lutea* Gray, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 322, pl. 4, figs. 15, 16, 1900; Dall, Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 116, 1904, reissued by Smithsonian Inst., 1910; Dall, U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 169, pl. 1, fig. 9, 1924.

Type locality: Icy Cape, Arctic Ocean.

Miocene: "Tertiary" of Aläksa, Unga, Unalaschka, St. Paul (?), Atcha (?), (Grewingk); Miocene of St. Paul Island, Atka Island, Unalaska, Morzhowi, Unga Island (Dall, 1896, as *T. alternidentata* B. & S.).

Recent: Arctic Ocean, Bering Sea, north Japan, the Aleutian Islands and east to Cooks Inlet, Alaska (Dall, 1921).

Dall in 1921 concluded that *T. venulosa* Schrenck was a valid variety of *lutea* Gray. In 1904 he questioned Grewingk's identification of *T. lutea* from the Alaskan Tertiary.

Genus APOLYMETIS Salisbury, 1929

Capsa sp., Bruguière, Encycl. Méth., Vol. 1, pl. 231, figs. 1*a-c*, 1797, not the type.

Capsa Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 84, 1799; not *Capsa* Humphrey, 1797, nor of Lamarck, Syst. Nouv. Class., p. 126, 1801, nor of Lamarck, Anim. s. Vert., Vol. 5, p. 553, 1818, *fide* Dall, December, 1900.

Caspa Bosc, Hist. Nat. Coq., p. 18, 1802, *err. pro Capsa*.

Metis H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 399, November, 1856, not of H. and A. Adams, *op. cit.*, p. 436, March, 1857, = *Myrsus* H. and A. Adams, *corrigenda*, p. 660, November, 1858; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 292, November, 1900; Trans. Wagner Inst. Sci., Vol. 3, pp. 1039-1041, December, 1900; not *Metis* Philippi, Archiv. f. Naturg., Vol. 9, p. 59, 1843; nor *Metis* Gistel, Naturg. Thierr. f. Höh. Schul., p. 174, 1848.

"*Lutricola* Blainville," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864, not of Blainville, Man. Malac., Vol. 1, p. 566, 1825.

Polymetis A. E. Salisbury, Proc. Malac. Soc. London, Vol. 18, p. 255, July 15, 1929, new name for *Metis;* not *Polymetis* Walsingham, 1903.

Apolymetis Salisbury, Proc. Malac. Soc. London, Vol. 18, p. 258, Nov., 1929, new name for *Polymetis*.

Type (by monotypy), "*Tellina meyeri* Phil" = *Tellina meyeri* Dunker, *fide* Philippi, Abbild. Beschreib, Conchyl., Vol. 2, *Tellina*, p. 89, pl. 4, fig. 1, Aug., 1846; East Indies.

Shell sub-orbicular, compressed, surface of valves sulcate; hinder flexuosity sub-median. Lateral teeth wanting. (H. and A. Adams.)

It is unfortunate that Schmidt's designation makes *Venus deflorata* Linnæus (figured by Bruguière, pl. 231, figs. 3*a*, 3*b*) the type of *Capsa*[1], for thus *Capsa* becomes a synonym of *Asaphis* Modeer, 1793. Bruguière's first species is much like our *Apolymetis*. *Asaphis* is a finely, radially striate genus quite different from *Apolymetis*.

Apolymetis biangulata (Carpenter)

Plate 20, Figure 16

Tellina alta Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 258, 1837; Hanley in Sowerby, Thes. Conch., Vol. 1, p. 332, pl. 62, fig. 200, 1847; not *Tellina alta* Conrad, Fossil Shells of the Tertiary Formations of North America, Vol. 1, no. 4, p. 41, Phila., 1833.

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[1] *Fide* Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 285, 1930.

Scrobicularia biangulata Carpenter, Proc. Zool. Soc. London, Pt. 23, pp. 213, 230, 1855; Brit. Assn. Adv. Sci., Rept. for 1856, p. 195, 1857.

Arcopagia medialis Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 8, p. 314, December, 1856; U. S. Pac. R. R. Reports, Vol. 6, Pt. 2, p. 70, pl. 2, fig. 6, 1857; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 174, 1909, reprint of Conrad, 1856.

Scrobicularia biangularis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 303, 1857, *err. pro biangulata*.

? *Arcopagia unda* Conrad, U. S. Pacific R. R. Repts., Vol. 7, p. 192, pl. 4, figs. 3, 4, 1857; type specimen, No. 13,328, U. S. Nat. Mus.

Lutricola alta Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864; Journ. de Conchyl., Vol. 12, p. 133, 1865; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 247, 1888; Keep, West Coast Shells, p. 197, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 186, 1892.

Metis alta Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 306, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1044, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 160, 1903; U. S. Geol. Surv., Bull. 309, pp. 24, 26, 107, 1907; Bull. 396, pp. 17, 24, 25, 118, pl. 6, fig. 1, Jan. 15, 1910; Bull. 398, pl. 28, same figure, 1910; Kew Univ. Calif. Publ. Geol., Vol. 8, p. 46, 1914; English, Vol. 8, p. 210, 1914; Clark, Vol. 8, p. 418, 1915; Nomland, Vol. 10, pp. 211, 219, 300-304, 1917; Dall, Nautilus, Vol. 32, p. 24, 1918; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 42, pl. 11, fig. 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 169, pl. 57, fig. 3, 1924; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Miocene: Vaqueros formation, Coalinga region, specific identity questioned (Arnold, 1910); Monterey County (Conrad, 1856, 1857, as *Arcopagia medialis*); El Toro Ranch, Monterey County (Cooper); upper and lower San Pablo and Santa Margarita formations, upper Miocene, middle California (Clark, 1915); Vaqueros-Temblor, lower and middle Miocene of middle California; Santa Margarita formation, upper Miocene, north of Coalinga, in the Tejon Hills, at the type section, and on Nacimiento River (Nomland, 1917).

Pliocene: Lower Pliocene of Elsmere and Holser canyons (English) and of various localities in eastern Ventura basin, southern California (Cooper; Arnold; etc.); Jacalitos and Etchegoin formations (Clark; Nomland); lower division of Carrizo formation, Imperial County (Kew); Pliocene of Pacific Beach, San Diego (Arnold, 1903); upper Pliocene at Santa Barbara (Cooper; Arnold).

Pleistocene: Lower San Pedro series at Deadman Island (Arnold, 1903); lower San Pedro of Nob Hill (Oldroyd); "upper Fernando" near mouth of Adams Canyon, Ventura County (Arnold, 1907); Spanish Bight, San Diego (Arnold, 1903); Pleistocene of San Diego (Dall, 1900, Wagner Inst.); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro formation (= Palos Verdes formation) of San Pedro, very common at Los Cerritos, less common at Deadman Island and Crawfish George's (Arnold); Pleistocene of Magdalena Bay (Dall, 1918), and upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Santa Barbara to San Diego, California.

As the Pacific coast species commonly known as *Metis alta* was originally described in 1837 as *Tellina alta*, its name is preoccupied by the prior *Tellina alta* of Conrad, 1833, and can no longer be used. The *Tellina alta*, 1833, is an entirely different species. The next available name appears to be *biangulata* Carpenter, 1855; but *T. turgida* and *obesa* Deshayes, 1854, should be compared when the literature and specimens are available. *Arcopagia medialis* Conrad appears to be a synonym, but *A. unda*, judging only from Conrad's figures, is much less certainly identical and may possibly belong to a different genus.

Apolymetis excavata (Sowerby)

Tellina excavata Sowerby, Reeve's Conch. Icon., Vol. 17, *Tellina*, pl. 26, fig. 138, 1867.

Metis excavata Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 271, 1909; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 467, pl. 23, fig. 6, 1926; Hanna and Hertlein, Vol. 16, p. 141, 1927.

Pliocene: Coyote Mountain, western Imperial County (Hanna); Loreto, Lower California, Mexico (Hanna and Hertlein).

Recent: Gulf of California, Mexico, South to Peru and the Galapagos Islands (Dall, 1909).

This species is the southern representative of *Apolymetis biangulata* (Carpenter).

Genus MACOMA Leach, 1819

Limicola Leach, Moll. Gt. Brit., p. 296, 1816; not *Limicola* Koch, 1816, nor Fischer, 1887.

Macoma Leach, in Ross's Voy. of Discovery in H. M. S. Isabella and Alexander, Appendix 2, p. lxii, 1819; Journ. de Physique, Vol. 88, p. 465, 1819; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 292, 1900; Trans. Wagner Inst. Sci., Vol. 3, pp. 1044, 1045, 1900; Woodring, Carnegie Inst., Publ. No. 366, p. 176, 1925.

"*Macroma* Leach," Gray, Ann. Phil., Vol. 25, p. 136, 1825; Proc. Zool. Soc. London, Pt. 15, p. 186, 1847, *err. pro Macoma*.

"*Psammotea* Turton," Gray, Proc. Zool. Soc. London, Pt. 15, p. 186, 1847, not of Turton, 1822, nor Lamarck, *fide* Dall, 1900.

Type (by monotypy), *Macoma tenera* Leach, = *Tellina calcarea* Gmelin, North American and boreal seas, to Japan and Port Etches, Alaska, in the Pacific, and to Long Island Sound, in the Atlantic.

Shell without lateral teeth; of a rounded subtrigonal shape, usually but slightly inflated, generally with a marked posterior flexure; sculpture lacking or of feeble concentric growth lines; pallial sinus generally confluent with the pallial line.

Geologic range: Tertiary to Recent.

Distribution: Widespread, generally cooler seas.

A number of subgeneric and sectional names have been used for minor subdivisions of *Macoma*, but they will not be considered in this paper. For a discussion of some of these subdivisions the reader may consult the two papers by Dall (1900) referred to above.

A preliminary study of the Quaternary Pacific coast Macomas suggests that overnaming has occurred. Lacking specific types to study at first hand, we have in most cases accepted the status as given by Dall in 1921.

Macoma nasuta (Conrad)

Plate 20, Figures 11*a*, 11*b*

Tellina nasuta Conrad, Jour. Acad. Nat. Sci. Phila., Ser. 1, p. 258, 1837; Hanley, in Sowerby's Thes. Conch., Vol. 1, *Tellina*, p. 314, pl. 64, fig. 224, 1846; not *Tellina nasuta* Conrad, U. S. Exploring Exped., Vol. 12, p. 725, 1849 (= *T. subnasuta* Conrad, 1865).

Macoma nasuta Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 93, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 248, 1888; Keep, West Coast Shells, p. 194, fig. 165, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 185, 1892; Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896; Proc. U. S. Nat. Mus., Vol. 23, pp. 307, 308, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1053, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 163, pl. 16, fig. 3, 1903; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 127, 1909; Arnold, U. S. Geol. Surv., Bull. 396, p. 156, pl. 25, fig. 5, Jan. 15, 1910; Arnold and Anderson, Bull. 398, p. 318, pl. 42, fig. 6, p. 328, pl. 47, fig. 5, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 593, 594, 596, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 418, 1915; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, pp. 28, 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 252, 1916; Nomland, Vol. 10, pp. 219, 300, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 279, pl. 23, figs. 1*a-d*, 1918; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 43, pl. 11, fig. 3, pl. 12, figs. 1, 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 47, 1921; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, pp. 550, 563, 1922; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 53, pl. 32, figs. 1*a*, 1*d*, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 174, pl. 45, figs. 1*a-d* (reproduction of Packard's figures), 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Shell of moderate to large size, compressed, subtrigonal in outline, beaks usually a little nearer the anterior extremity, anterior dorsal margin rounding smoothly into the broader curve of the ventral margin, posterior dorsal margin descending in a nearly straight line to the narrow, truncated posterior extremity, posterior extremity flexed to the right; sculpture of inconspicuous growth lines only; hinge strong and wide for a species of this genus.

Dimensions (according to Conrad, 1837): Length, 1¼ inches; height, 1⅓.

Type specimen: At the Academy of Natural Sciences, Philadelphia.

Type locality: Near San Diego, California; Recent.

? Oligocene: Oligocene (?) sandstones at Miller's Beach, Coos Bay, Oregon (Dall, 1909).

Miocene: Lower Miocene on the Strait of Juan de Fuca, Clallam County, Washington; Montesano formation and upper Miocene of western Washington (Weaver); Vaqueros formation of California (Nomland); San Pablo formation, upper Miocene of middle California (Clark; Martin); Empire formation of Coos Bay region, Oregon (Dall); Miocene at Sunol, Alameda County, and of Foxiu's Ranch, Santa Barbara County (Cooper); Miocene of Nushagak, Alaska, and of British Columbia (Dall, 1896); Santa Margarita formation, upper Miocene, north of Coalinga (Nomland).

Pliocene: Eagle Prairie and Danger Creek, Humboldt County; Santa Rosa; San Fernando (Cooper); lower and upper Wildcat, Pliocene of northern California (Martin; Howe); Merced and Purisima formations of the region south of San Francisco (Dall, 1909; Martin); region near Petaluma (Dickerson); Etchegoin of Sargent oil field and of the Coalinga region (Martin; Nomland); Jacalitos and Etchegoin formations (Arnold; Clark); lower Fernando of Holser Canyon, Los Angeles County (English); middle Pliocene of Santa Clara Valley region, Los Angeles County (coll. by Gale); middle Pliocene of Pacific Beach, San Diego (Arnold, 1903); Pico near Ventura (Waterfall).

Pleistocene: Lower San Pedro series of San Pedro and Deadman Island, rather common; Pleistocene near Barlow's Ranch and at the old irrigation ditch near Ventura (Arnold, 1903); "Saugus" near Ventura (Waterfall); lower part of the Pleistocene between Santa Paula and Ventura (coll. by Grant); Tomales Bay, Marin County (Dickerson); Pleistocene of Pacific Beach and Spanish Bight, San Diego (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro fauna of Los Cerritos, Long Beach, Crawfish George's, Deadman Island, and San Pedro (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Kodiak Island and Cooks Inlet, Alaska, south to Scammons Lagoon, Lower California (Dall).

This is a rather large, rather elongate, and strongly flexed shell, with the beaks relatively anterior. It is a very common species and has persisted from at least as early as the lower Miocene. Packard found it living at various depths in San Francisco Bay.

According to Dall (1909) the species seems to occur in Japan under the name of *dissimilis* von Martens, 1865. *Tellina tersa* Gould, 1852, is supposed to be the young of *M. nasuta.*

Macoma nasuta (Conrad) variety **jacalitosana** Arnold

Macoma jacalitosana Arnold, U. S. Geol. Surv., Bull. 396, p. 65, pl. 16, fig. 2, January 15, 1910; Bull. 398, p. 110, pl. 38, fig. 2, 1910.

Type specimen: In the U. S. National Museum, Cat. No. 156,613.

Type locality: Just east of junction of Jacalitos and Jasper creeks, Coalinga region, California; Pliocene.

Pliocene: Jacalitos formation, lower Pliocene of Coalinga district (Arnold).

According to Arnold "*M. jacalitosana* belongs to the same general group as *M. nasuta* Conrad . . . but is very much more inflated, narrower posteriorly, and carries the posterior carina or fold much farther below the dorsal margin than the latter."

Macoma nasuta (Conrad) variety **kelseyi** Dall

Macoma kelseyi Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1052, pl. 49, fig. 7, December, 1900; U. S. Nat. Mus., Bull. 112, p. 47, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Station, Vol. 4, p. 53, March, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 171, 1924; Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 417, 1926.

Macoma nasuta Conrad, var. *kelseyi* Dall, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 164, 1903.

Shell like that of typical *nasuta*, but somewhat more elongate, often larger, with less flexure of the posterior end.

Type specimen: In the U. S. National Museum.

Type locality: San Diego, California; Pleistocene.

Pliocene: Turtle Bay, Lower California, Mexico (Jordan and Hertlein); Etchegoin formation in well cores in the southern end of the San Joaquin basin (H. R. G.).
Pleistocene: San Diego (Dall, 1900); foot of Twenty-sixth Street, San Diego (Arnold); rare in upper San Pedro series at San Pedro and Los Cerritos (Arnold).
Recent: Puget Sound (I. S. Oldroyd).

This shell is similar to that of typical *nasuta*, but is narrower, less flexed and the posterior end is somewhat more obliquely truncated. The living range "San Diego and south" given by Arnold apparently on Dall's authority, must be an error. Mrs. Oldroyd has collected Recent specimens in Puget Sound, which is the only Recent record of this variety so far as the writers know. It is not certain whether this variety is of significance or not.

Macoma inquinata (Deshayes)

Plate 20, Figure 5

Tellina inquinata Deshayes, Proc. Zool. Soc. London for 1854, p. 357; Hanley, in Sowerby's Thes. Conch., Vol. 1, *Tellina*, pl. 30, fig. 164, 1846; Reeve, Conch. Icon., Vol. 17, *Tellina*, pl. 30, species 164, 1867; Römer Syst. Conchyl. Cab., Vol. 10, p. 227, pl. 44, figs. 1-4, 1871±.

Macoma inquinata Deshayes, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 689, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 93, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 248, 1888; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 307, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1053, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 162, pl. 16, fig. 4, 1903; U. S. Geol. Surv., Bull. 396, p. 164, pl. 29, fig. 3, 1910; Bull. 398, pl. 51, fig. 3, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 596, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 252, 1916; Nomland, Vol. 10, p. 219, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 278, pl. 23, figs. 2, 3, pl. 24, figs. 1*a-b*, 1918; Dall, U. S. Nat. Mus., Bull. 112, p. 47, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 311, 1922; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Station, Vol. 4, p. 54, pl. 32, figs. 2*a-b*, 3*a-b*, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 172, pl. 45, figs. 2*a-b*, 3*a-b*, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924; T. S. Oldroyd, U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925.

Shell of medium size, not always strongly flexed, moderately elongate, beaks anterior.

Type locality: Vancouver Island, British Columbia; Recent.

Pliocene: Etchegoin formation of the Coalinga region (Arnold and Anderson; Nomland); Merced and Purisima formations of middle California (Martin; Nomland); Twelve-Mile House, San Mateo County; San Fernando, Los Angeles County (Cooper).
Pleistocene: Coos conglomerate of Coos Bay, Oregon (Arnold and Hannibal; Howe); "Pliocene" and lower San Pedro series of Deadman Island, Los Angeles County, common; foot of Twenty-sixth Street, San Diego (Arnold, 1903); lower San Pedro fauna of Nob Hill cut at San Pedro (T. S. Oldroyd); upper San Pedro series at Deadman Island, San Pedro, Los Cerritos, and Crawfish George's, Los Angeles County (Arnold, 1903); upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).
Recent: Bering Strait to Japan on the west and to Monterey Bay, California, on the east (Dall, 1921).

Macoma inquinata (Deshayes) variety **arnheimi** Dall

Macoma inquinata var. *arnheimi* Dall, Proc. U. S. Nat. Mus., Vol. 52, p. 414, December 27, 1916; Amer. Jour. Sci., Ser. 5, Vol. 4, p. 311, 1922.

Macoma inquinata arnheimi Dall, U. S. Nat. Mus., Bull. 112, p. 47, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 172, pl. 42, fig. 9, 1924.

Shell of medium size, short, not much flexed, beaks slightly anterior.

Type specimen: In the U. S. National Museum, Cat. No. 122,537.

Type locality: Kodiak Island, Alaska; Recent.

? Miocene: Quillayute formation near Quillayute, Washington (Reagan[1]).
Pleistocene: "Pleistocene of San Pedro" (Dall, 1921).
Recent: Kodiak Island, Alaska, to San Francisco, California (Dall, 1921).

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[1] As *Macoma inquinata* Deshayes, Trans. Kansas Acad. Sci., Vol. 22, p. 209, 1909. Arnold and Hannibal (Proc. Amer. Phil. Soc., Vol. 52, p. 604, 1913) concluded that Reagan's Quillayute fossils came originally from the Empire formation sandstones, but were transported by the aborigines to the glacial filling of the valley of the Quillayute River.

Dall described this variety as follows: "Shell resembling the typical *inquinata*, but shorter, and relatively more plump; the beaks 15 mm. behind the anterior end; the basal margin somewhat produced; the rostration shorter, pronounced, and less obliquely twisted. Length, 38; height, 30; diameter, 15 mm." It is possible that this is the typical variety of *inquinata*.

Dall (1922) considered Reagan's *M. inquinata* questionably equivalent to the variety *arnheimi*, which, if true, would extend the range of *arnheimi* to the Miocene.

Macoma inquinata (Deshayes) variety **affinis** Nomland

Macoma inquinata affinis Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 233, pl. 9, figs. 1, 1*a-b*, April, 1917.

Type specimen: In the University of California collection.

Type locality: Coalinga district, San Joaquin Valley, California; Pliocene.

Pliocene: Mya japonica zone, uppermost part of Etchegoin formation, upper Pliocene, Coalinga district, California (Nomland).

According to Nomland, this variety "may be distinguished from the typical *Macoma inquinata* (Deshayes) by its larger size, the flange immediately anterior to the beaks, depressed area extending from umbones to posterior ventral margin, rather long ligamental groove, and increased convexity near middle of base."

This variety is somewhat like *M. inquinata arnheimi* Dall and like that variety is probably of no significance.

Macoma brota Dall

Tellina edentula Broderip and Sowerby, Zool. Journ., Vol. 4, p. 363, January, 1829; Sowerby, Zool. Beechey's Voyage, H. M. S. Blossom, p. 154, pl. 41, fig. 5, pl. 44, fig. 7, 1839; Hanley, Descr. Cat. Rec. Biv. Shells, p. 71, 1842; Hanley, in Sowerby's Thes. Conch., Vol. 1, p. 315, pl. 65, fig. 243, 1847; ? Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St.-Petersburg, Verhandlungen for the years 1848 and 1849, p. 357, pl. 7, figs. 1*a-c*, 1850; not *Tellina edentula* Spengler, 1793.

Macoma edentula Broderip and Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 307, 1900.

Macoma brota Dall, Proc. U. S. Nat. Mus., Vol. 52, p. 413, December 27, 1916; Canadian Arctic Exped., Vol. 8, Pt. A, p. 29A, 1919; U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 170, pl. 9, fig. 2, 1924.

Type specimen: Of *M. brota* Dall, in U. S. National Museum.

Type locality: Bering Strait.

? Tertiary: Tertiary of Aläksa, Möller, Unga (Grewingk).
Pleistocene: East and west sides of Coppermine River, Northwest Territories, Canada (Dall, 1919).
Recent: Arctic Ocean, Bering Sea, south to Puget Sound (Dall, 1921).

According to Grewingk, *T. dilatata* Girard[1] may belong to this species or to *T. lutea*. Dall considered Grewingk's specimens sufficiently different from Recent examples of "*edentula*" to rename the variety *grewingki*.[2] The species is closely related to *M. calcarea*.

Macoma brota Dall variety **lipara** Dall

Macoma brota, new variety, *lipara* Dall, Proc. U. S. Nat. Mus., Vol. 52, p. 414, December 27, 1916.

Macoma brota lipara Dall, U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 171, pl. 42, fig. 6, 1924.

Shell resembling that of *brota*, but more rotund, less rostrate, with a wider and rounder anterior end, shorter and more rounded posterior end, and more polished surface.

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[1] A. Erman's Archiv Wiss. Kunde Russland, Vol. 3, p. 544, figs. 5*a*, 5*b*, 1843.

[2] Washington Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 116, 1904, reissued by the Smithsonian Institution, 1910.

Type specimen: U. S. National Museum, Cat. No. 223,032.

Recent: Bering Sea to Puget Sound (Dall, 1921).

According to Dall, 1921, the variety and the typical form have the same geographical distribution; but variety *lipara* had not been seen from Arctic waters when originally described. The respective measurements are as follows, in millimeters: *M. brota:* height, 53; length, 74; diameter, 22; posterior end, 32; *M. lipara:* height, 57; length, 74; diameter, 25; posterior end, 33 (Dall, 1916).

Howe appears to have considered this variety and *Macoma astori* Dall identical, but he did not use the older name. The variety *lipara* seems to be a little more evenly rounded posteriorly, and lacking sufficient authentic comparative material we have not disturbed Dall's arrangement. However, here as elsewhere, changes may be necessary when the group receives critical treatment.

Macoma astori Dall

Macoma astori Dall, U. S. Geol. Surv., Prof. Paper 59, p. 128, pl. 14, figs. 1, 11, April 2, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913.

Type specimen: In the U. S. National Museum.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Empire formation of Coos Bay, Oregon (Dall; Arnold and Hannibal).

This species is very close to, if not identical with *M. brota* variety *lipara* Dall. From Howe's remarks,[1] it appears that Dall could not be relied upon in discriminating between these two forms, which goes to illustrate the futility of making such minute subdivisions. There seems to be a slight difference in the outline of the posterior profile of the shell, which is probably not more than would occur between two individuals of the same parents. The variety *lipara* is probably a superfluous name for *M. astori*, but is retained here until a thorough review of the Pacific coast Macomas permits these changes to be accompanied by a full discussion based upon large collections.

Macoma calcarea (Gmelin)

Tellina calcarea Gmelin, Systema Naturæ, Ed. 13, Vol. I, pt. 6, p. 3236, 1791; Hanley, Descr. Cat. Rec. Biv. Shells, p. 46, pl. 4, fig. 43, 1842; Möller, Index Moll. Groen., p. 20, 1842; ? Hanley, Sowerby's Thes. Conch., Vol. 1, *Tellina*, p. 314, pl. 62, fig. 183, 1847.

Tellina lata Gmelin, Systema Naturæ, Ed. 13, Vol. 1, pt. 6, p. 3237, 1791.

Tellina sabulosa Spengler, Skrift. Naturh. Selsk., Vol. 4, p. 114, 1794.

Macoma tenera Leach, in Ross's Voy. of Discovery in H. M. S. Isabella and Alexander, Appendix 2, p. lxii, 1819; Journ. de Phys., Vol. 88, p. 465, 1819.

Tellina proxima (Brown MS.) Sowerby, Zool. Beechey's Voy. Blossom, p. 154, pl. 44, fig. 4, 1839; Hanley, in Sowerby's Thes. Conch., Vol. 1, *Tellina*, p. 313, pl. 66, fig. 264, pl. 59, fig. 115, 1847; Forbes and Hanley, Hist. Brit. Moll., Vol. 1, p. 307, pl. 21, fig. 1, 1850; Vol. 4, p. 251, pl. 133, fig. 3, 1853.

Tellina sordida Couthouy, Boston Journ. Nat. Hist., Vol. 2, p. 59, pl. 3, fig. 11, 1838.

Sanguinolaria sordida Couthouy, Gould, Invert. Mass., p. 67, 1841.

Macoma proxima Sowerby, Gould, Invert. Mass., Binney Ed., p. 95, fig. 401, 1870.

Macoma calcarea Gmelin, Sars, Moll. Reg. Arct. Norv., p. 76, pl. 6, figs. 2*a*-*b*, 1878; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 124, 1868-9 (as of "Chemn. sp."); Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 248, 1888 (as of Chemnitz); Dall, Proc. U. S. Nat. Mus., Vol. 23, pp. 299, 307, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1046, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 161, pl. 16, fig. 2, 1903; Dall, Washington Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 121, 1904; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 126, 127, 1909; Weaver, Washington Geol. Survey, Bull. 15, p. 18, 1912; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 592, 1913; Weaver, Univ. Washington Publ. Geol., Vol. 1, no. 1, pp. 28, 32, 1916;

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[1] Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922.

Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 252, 1916; Dall, Canadian Arctic Exped., Vol. 8, Pt. A, p. 29A, 1919; Baker, Bull. Amer. Mus. Nat. Hist., Vol. 41, art. 11, p. 499, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 47, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 173, pl. 42, fig. 5, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 251, 253, 1929.

Macoma sabulosa Spengler, Dall, Exped. to Point Barrow, p. 183, 1885; Dall, in Spurr, U. S. Geol. Survey, 20th Ann. Rept., Pt. 7, p. 264, 1900; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 45, 1913; Dall, Canadian Arctic Exped., Vol. 8, Pt. A, p. 29A, 1919.

"*Tellina albaria* (Conrad)," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 184, pl. 2, fig. 15, 1909, not of Conrad.

Oligocene: Upper Oligocene of western Washington (Weaver, 1912, 1916).

Miocene: Empire formation of Coos Bay, Cape Blanco region, Oregon (Dall, 1909; Arnold and Hannibal); Bear River Miocene, questionably (Martin), probably Pliocene; Cape Yaktag, Alaska (Dall, in Spurr, 1900).

Pliocene: Lower and middle parts of the Wildcat formation, northern California; Purisima formation south of San Francisco (Martin); Merced formation of middle California (Arnold and Hannibal); Pico formation near Ventura (Waterfall); near Nome, Alaska (Dall, in Moffit, 1913).

Pleistocene: Coos conglomerate, Coos Bay, Oregon (Howe); "Pliocene" and lower San Pedro series of Deadman Island, Los Angeles County (Arnold); "Saugus" formation near Ventura (Waterfall); foot of Twenty-sixth Street and at northeast side of Mission Bay, San Diego (Stephens); Pleistocene of Douglas Island, Juneau Harbor, Alaska (Dall, 1904); and of Arctic Sound, several localities, Northwest Territories, Canada (Dall, 1919); Pleistocene of Scandinavia, Scotland, Greenland, etc.

Recent: Arctic Ocean to northern Japan and to Monterey Bay, California; circumboreal (Dall, 1921).

This is a widely distributed and ancient species. It is possible that the Oligocene forms belong to a different, but closely related species. There is a recognizable, individual variation in shape, but Hanley's figure of *calcarea* in the "Thesaurus Conchyliorum" appears to be extreme. The few synonyms given above seem to be almost beyond question.

Macoma moesta (Deshayes)

Plate 20, Figure 3

Tellina moesta Deshayes, Proc. Zool. Soc. London for 1854, p. 361.

Tellina lutea Krause, 1885, not Gray, 1828[1], *fide* Dall, 1900.

Macoma krausei Dall, Proc. U. S. National Museum, Vol. 23, pp. 298, 307, 322, pl. 4, fig. 8, November 14, 1900.

Macoma moesta Deshayes, Dall, U. S. Nat. Mus., Bull. 112, p. 47, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 173, 1924.

? Pliocene: Etchegoin formation of the Federal Exploration Company well, Kinsella No. 1, near Tipton, Tulare Co., San Joaquin basin, depth 2393 to 3175 feet, middle or upper Pliocene, about ten specimens, most of them poor (H. R. G.).

Recent: Arctic Ocean, Bering Sea, Shumagin Islands; circumboreal (Dall, 1921).

According to Dall (1900), *M. krausei* is "characterized by its oval compressed form, low posterior beaks, and short, hardly flexed posterior end." *M. krausei* is a synonym of *M. moesta*.

The Etchegoin specimens, upon which the Pliocene record is based, vary in shape, but some of them match the typical form. They are like *M. calcarea* except that the posterior instead of striking off abruptly is rounded out, somewhat like the posterior end of *M. secta* without the cut. This rounding out of the posterior end as well as the anterior gives the shell an unusually large apical angle, with beaks hardly protruding. The hinge is weak. One of the Etchegoin specimens is larger than Dall's and relatively deeper. This is the only species we have noted with posterior beaks, rounded ends, large apical angle, and weak hinge, which are characters exhibited by nearly all of the Etchegoin specimens. One or two specimens have an apical angle more like that of *M. calcarea*, but most of them have a convex posterior dorsal edge which refuses to fit the outline of *calcarea*. Perhaps this form should be considered a variety of *M. calcarea*, with which it intergrades.

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[1] The original descriptions of Krause, 1885, and of Gray, 1828, have not been seen by the present authors.

Macoma moesta (Deshayes) variety **acolasta** Dall

Plate 14, Figure 7; Plate 20, Figures 4*a*, 4*b*, 10

Macoma acolasta Dall, West American Scientist, Vol. 19, No. 3, p. 21, June 15, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 19, pl. 8, figs. 2, 3, 1925; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Shell small, inequilateral, inequivalve, posterior end somewhat bent to the right, surface smooth, except for faint incremental lines which are stronger on the posterior area; beaks not prominent, nearer the posterior end; both dorsal slopes somewhat arched, anterior end evenly rounded, base slightly arcuate, posterior end very slightly rostrate; left valve more convex; hinge feeble, right valve with two small cardinals, left valve with a single bifid tooth; pallial sinus in the left valve, subovate, reaching a little beyond the middle of the valve, the lower two-thirds coalescent with the pallial line; in the right valve the sinus almost triangular. Height, 12; length, 22; diameter, 6.5 mm. (Dall, 1921.)

Type specimen: In the U. S. National Museum.

Type locality: San Quintin Bay, Lower California, Mexico; Pleistocene.

Pleistocene: San Quintin Bay, west coast of Lower California, Mexico (Dall); locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. (U. S. G.).

This variety is like typical *moesta*, but is more elongate. The beaks are nearer the angulated end, as in *M. calcarea*, to which it is possibly related, but the dorsal area under the beaks is not concave and the shell is more elongate than that of *calcarea*.

Jordan attributed an upper Pleistocene age to the San Quintin Bay deposits from which the type of this variety was collected.

Macoma balthica (Linnæus)

Plate 14, Figures 6*a*, 6*b*; Plate 20, Figures 7*a*, 7*b*

Tellina balthica Linnæus, Syst. Nat., Ed. 10, p. 674, 1758; Ed. 12, p. 1116, 1767; Born, Test. Musei Cæsarei Vindobonensis, p. 38, pl. 2, fig. 14, 1780; Chemnitz, Neues Syst. Conch. Cab., Vol. 6, p. 133, pl. 13, fig. 128, 1782; Hanley, in Sowerby's Thes. Conch., Vol. 1, *Tellina*, p. 316, pl. 59, fig. 121, 1847.

Venus fragilis O. Fabricius, Fauna Groenl., p. 413, 1780, not of Linnæus, *fide* Hanley, 1847, and Dall, 1900.

Psammobia fusca Say, Journ. Acad. Nat. Sci. Phila., Vol. 5, p. 219, 1827.

Tellina inconspicua Broderip and Sowerby, Zool. Journ., Vol. 4, p. 363, 1829; Sowerby, Zool. Beechey's Voy., p. 153. pl. 41, fig. 6, 1839; Mighels, Boston Journ. Nat. Hist., Vol. 4, p. 317, 1843; Hanley, in Sowerby's Thes. Conch., Vol. 1, *Tellina*, p. 317, pl. 59, fig. 120, 1847.

Sanguinolaria fusca Say, Conrad, Amer. Marine Conch., p. 34, pl. 7, fig. 1, 1831; Gould, Inv. Mass., p. 66, fig. 42, 1841.

Tellina grönlandica (Beck MS.) Lyell, Trans. Geol. Soc. London, Ser. 2, Vol. 6, p. 137, pl. 16, figs. 8, 8*a*, 1839.

Tellina fusca Say, Philippi, Abbild. und Beschr., Vol. 2, *Tellina*, p. 24, pl. 3, fig. 3, 1845; Hanley, in Sowerby's Thes. Conch., Vol. 1, *Tellina*, p. 316, pl. 59, fig. 117, 1847.

Tellina fabricii Hanley, in Sowerby's Thes. Conch., Vol. 1, *Tellina*, p. 318, pl. 49, fig. 112, 1847.

Macoma fusca Say, Gould, Inv. Mass., Binney Ed., p. 93, fig. 42, 1870.

Macoma inconspicua Broderip and Sowerby, Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896; Canadian Arctic Exped., Vol. 8, Pt. A, p. 29A, 1919.

Macoma balthica Linnæus, Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 1051, 1053, 1900; Proc. U. S. Nat. Mus., Vol. 23, p. 298, 1900; Canadian Arctic Exped., Vol. 8, Pt. A, p. 29A, 1919; U. S. Nat. Mus., Bull. 112, p. 47, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 172, pl. 44, figs. 1, 2, 9, 1924.

Macoma balthica Linné, var. *inconspicua* Broderip and Sowerby, Dall, Washington Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 121, 1904, reissued by Smithsonian Institution, 1910.

Suborbicular, slightly triangular, thick, equilateral, more or less ventricose, white or pale flesh colored, with the interior usually rosy, smooth, not glossy; ventral edge arcuated, rising behind; front dorsal edge short and not much sloping, nearly straight adjacent to the prominent beaks, becoming convex subsequently; hinder dorsal edge nearly straight or but slightly convex, much sloping; anterior side rounded; posterior side angulated, but with the tip rounded; ligament large, and prominent; fold and flexure obsolete; teeth small. (Hanley.)

Length, 16 to 27 mm.; height, 14 to 22 mm.

Miocene: St. Paul Island, Alaska, and Miocene of British Columbia (Dall, 1896, as *M. inconspicua*).
Pliocene: California (Dall, 1896, as *inconspicua*).
Pleistocene: Douglas Island, Juneau Harbor, Alaska (Dall, 1904, as *M. balthica* var. *inconspicua*); southwest part of Victoria Island, Northwest Territories (Dall, 1919, as *inconspicua*); Coppermine River, five miles from its mouth, Northwest Territories (Dall, 1919); various other northern and northeastern localities (Lyell; etc.); California (Dall, 1896, as *inconspicua*).
Recent: Point Barrow, Arctic Ocean, to northern Japan and San Diego, California (Dall, 1921); also north Atlantic, Baltic.

Dall reported this species from the Pliocene and Pleistocene of California, but did not give precise localities. *Macoma pabloensis* Clark,[1] of the upper Miocene of middle California, seems to be related, but is more rounded.

Macoma planiuscula, new species

Plate 14, Figures 11*a*, 11*b*; Plate 20, Figures 8*a*, 8*b*

"*Macoma carlottensis* Whiteaves," Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 308, 1900; Bull. 112, U. S. Nat. Mus., p. 47, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 175, 1924; and of other recent Pacific coast authors; not of Whiteaves, 1880.
? "*Tellina carlottensis* Whiteaves," Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896.

Shell resembling that of *Macoma balthica* (Linnæus), but somewhat more elongate, with the valves significantly flatter, the right valve slightly flexed to the right at the posterior end; shell moderately heavy, surface polished.

Dimensions: Length, 23.5 mm.; height, 16 mm.; convexity of the two valves, 6 mm.

Type specimen: In the Oldroyd Collection at Stanford University, labeled 301-1A.

Type locality: Nunivak Island, Alaska; Recent.

? *Miocene:* Nulato, St. Paul Island, Nushagak, Unalaska, Alaska; also British Columbia (Dall, 1896, as "*Tellina carlottensis* Whiteaves."
Recent: Arctic Ocean to Puget Sound (Dall, 1921, as "*carlottensis*").

Authentic specimens of *Macoma carlottensis* Whiteaves (Rept. Geol. Surv. Canada for 1878-79, p. 196B, fig. 1, 1880) from the Museum of the Canadian Bureau of Mines at Ottawa, when compared with Dall's discussions and with specimens identified by Dall as of Whiteaves' species, show that Dall confused *carlottensis* with a Recent form apparently undescribed. This unfortunate confusion resulted in Dall's redescribing the type *carlottensis* under the name of *Macoma inflatula*.[2] *Macoma quadrana* Dall appears to be very close to *inflatula* (= *carlottensis* Whiteaves). The true *carlottensis* is figured on plate 20, figures 1*a*, 1*b*, 2*a*, 2*b*.

Tellina ? diabloensis Clark (Univ. Calif. Publ. Geol., Vol. 8, p. 471, pl. 61, fig. 5, 1915, not *Macoma diabloensis* Clark, p. 475, pl. 61, figs. 8, 9, 10, 1915) has the shape of *M. planiuscula*, but the similarity is superficial, as Clark's species has the lateral teeth of a *Tellina*.

Macoma middendorffi Dall

Tellina edentula Middendorff, Siber. Reise, p. 259 in part, pl. 21, fig. 1 only, 1850, *fide* Dall, 1884.
Macoma (*edentula* Brod. and Sby. var ?) *middendorffi* Dall, Proc. U. S. Nat. Mus., Vol. 7, p. 247, 1884.
Macoma edentula Brod. and Sby. var. *middendorffii* Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 308, pl. 4, fig. 11, 1886.
Macoma middendorfii Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896.
Macoma middendorffii Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 306, 1900; in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913; Dall, Prof. Paper 125-C, p. 33, pl. 6, figs. 11, 13, 1920; U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 170, pl. 53, fig. I, 1924.

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[1] Univ. Calif. Publ. Geol., Vol. 8, pp. 475, 476, pl. 61, figs. 1, 2, 17, 1915.

[2] Bull. Nat. Hist. Soc. Brit. Columbia, No. 2, p. 11, pl. 1, figs. 19, 20, 1897; figured also by Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, pl. 13, fig. 15, pl. 1, figs. 2, 8, 1924.

Type specimen: In the U. S. National Museum.

Type locality: Bering Sea; Recent.

Miocene: St. Paul Island, Nushagak, Port Möller, Morzhowi, Unga Island, Alaska (Dall, 1896).
Pliocene: Just west of Snake River and at a number of Pliocene localities in the Nome region of Alaska (Dall, 1913, 1920).
Recent: Bering Strait, south to the Commander and Aleutian Islands and eastward to Chirikoff Island, Alaska (Dall, 1921).

According to Dall, this species is recognizable "by its high triangular form, solid shell, with broad hinge plate and flattened left valve." He suggested (1886) that it might be a race of *edentula*, due to peculiar environmental conditions.

Macoma incongrua (von Martens)

Tellina incongrua von Martens, Ann. Mag. Nat. Hist., Ser. 3, Vol. 16, pp. 430, 431, 1865.

Tellina rotundata Sowerby, in Reeve's Conch. Icon., Vol. 17, *Tellina*, pl. 27, fig. 146, June, 1867.

Macoma incongrua von Martens, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 306, 1900; U. S. Nat. Mus., Bull. 112, p. 46, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 170, pl. 42, fig. 10, 1924.

Macoma rotundata Sowerby, Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913.

Type locality: Of *incongrua*, Yokohama, Japan; Recent.

Pliocene: Center Creek, and of the second beach, east of Nome, Alaska (Dall, 1913).
Recent: Arctic Ocean, south to Japan on the west and to San Diego, California, on the east (Dall, 1921).

According to Dall (1900), *Tellina nasuta* var. *truncata* of Middendorff, 1851 (not *Tellina truncata* Jonas, 1844) and *Macoma californiensis* Bertin, 1878, are synonyms.

Macoma yoldiformis Carpenter

Macoma yoldiformis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 56, 1865; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 249, 1888; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 309, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 165, pl. 16, fig. 6, 1903; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 252, 1916; Dall, U. S. Nat. Mus., Bull. 112, p. 48, 1921; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 177, pl. 44, fig. 6, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: Middle Wildcat formation of northern California (Martin).
Pleistocene: Lower San Pedro series of Deadman Island, rare (Arnold); "Saugus" formation, near Ventura (Waterfall); Spanish Bight, San Diego Bay, common (Arnold); upper Pleistocene at San Ignacio Lagoon and San Quintin Bay, west coast of Lower California, Mexico (Jordan, 1924, 1926).
Recent: Puget Sound to San Diego, California.

This is a small, thin, smooth shell something like *Tellina bodegensis*, but smaller, more evenly rounded posteriorly, and with weaker concentric sculpture. Its name is appropriate and suggests its shape.

Section REXITHAERUS Conrad, 1869

Rexithærus Conrad, in Tryon, "Catalogue of *Tellinidæ*," p. 104, Supplement to Amer. Journ. Conch., Vol. 4, pt. 5, 1869; Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 292, 1900; Trans. Wagner Inst. Sci., Vol. 3, p. 1045, 1900.

Type (by subsequent designation, Dall, 1900), *Macoma secta* Conrad.

Shell large, inequivalve, with a smooth surface, a large and strong, deep-set ligament, behind which the dorsal margin is conspicuously produced upward (Dall).

Macoma secta (Conrad)

Plate 20, Figures 6*a*, 6*b*

Tellina secta Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 257, 1837; Hanley in Sowerby's Thes. Conch., *Tellina*, p. 327, pl. 65, figs. 245, 248, 1847.

Macoma secta Conrad, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 401, 1858: Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 249, 1888; Keep, West Coast Shells, p. 191, fig. 163, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 164, pl. 16, fig. 5, 1903; Arnold, U. S. Geol. Surv., Bull. 396, p. 30, pl. 20, fig. 1, Jan. 15, 1910; Arnold and Anderson, Bull. 398, pp. 110, 131, 318, pl. 42, fig. 1, 1910; Thompson, Rept. B. C. Commissioner of Fisheries for 1912, pp. I-41, I-48, pl. 8, 1913; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Clark, Vol. 8, pp. 404, 418, 1915; Martin, Vol. 9, p. 252, 1916; Weaver, Univ. Wash. Publ. Geol., Vol. 1, pp. 28, 33, 1916; Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 211, 219, 330, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 280, pl. 25, fig. 8, 1918; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 44, pl. 12, figs. 3, 4, pl. 13, fig. 1, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 48, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 178, pl. 44, fig. 8, 1924; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

"*Macoma* var. *edulis*, Nutt.", Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864.

Macoma (*Rexithærus*) *secta* Conrad, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1053, 1900.

Type specimen: ? In the Academy of Natural Sciences of Philadelphia.

Type locality: San Diego, California; Recent.

Miocene: Lower Neocene; *Scutella breweriana* zone; Santa Margarita formation; lower and upper parts of San Pablo formation of middle California (Clark; Nomland); Montesano formation, upper Miocene, Washington (Weaver); Empire formation of western Oregon.

Pliocene: San Fernando (Cooper); lower Fernando of Holser Canyon, Los Angeles County (English); Etchegoin formation of the Coalinga region (Arnold, 1910; Martin; Nomland); upper part of the Wildcat formation of northern California (Martin); Etchegoin of the Sargent oil field, near Sargent (Martin); Santa Barbara (Cooper, as Pliocene).

Pleistocene: Santa Barbara to San Diego (Cooper); lower San Pedro series of Deadman Island and San Pedro (Arnold, 1903); Coos conglomerate of Coos Bay region, Oregon (Howe); Spanish Bight, San Diego Bay (Arnold, 1903); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan, 1924); upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, San Pedro, and Long Beach (Arnold, 1903); upper San Pedro fauna at Santa Monica (T. S. Oldroyd collection); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Vancouver Island, British Columbia, south to Gulf of California, Mexico; also Japan.

This common shell has a trapezoidal shape and a smooth, polished surface when fresh. Dall (1900) states that *Tellina ligamentina* Deshayes, 1843, *Tellina japonica* Deshayes, 1854, and *Tellina denticulāta* of Sowerby, 1867, not of Deshayes, 1854, are synonyms.

Macoma indentata Carpenter

Macoma indentata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 639, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 248, 1888; Keep, West Coast Shells, p. 195, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 185, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 161, 162, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 526, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Martin, Vol. 9, p. 252, 1916; Nomland, Vol. 10, p. 300 (questionably), 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 48, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 178, pl. 44, fig. 4, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Macoma (*Rexithærus*) *indentata* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 309, 1900.

? *Macoma* (*Rexithærus*) *indentata* var. *tenuirostris* Dall, Proc. U. S. Nat. Mus., Vol. 23, p. 309, 1900.

? *Macoma indentata tenuirostris* Dall, U. S. Nat. Mus., Bull. 112, p. 48, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 178, 1900.

Type locality: San Pedro, California; Recent.

Miocene: El Toro Ranch, Monterey County; Griswold's, San Benito County (Cooper); Empire formation of Coos Bay, Oregon (Howe); Santa Margarita formation, upper Miocene, north of Coalinga (Nomland).

Pliocene: Etchegoin formation of the Coalinga region (Martin; Nomland, questionably); lower Fernando of Elsmere Canyon (Arnold, 1907; English, 1914) and of Holser Canyon, Los Angeles County (English); Etchegoin of Sargent oil field (Martin).

Pleistocene: Coos conglomerate of Coos Bay, Pliocene or Pleistocene (Howe); lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd, 1925); Spanish Bight, San Diego (Arnold, 1903); upper San Pedro at Los Cerritos and San Pedro, rare (Arnold, 1903); upper San Pedro at Santa Monica (F. C. Clark collection); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Puget Sound to Lower California, Mexico.

Macoma molinana Dall

Macoma molinana Dall, U. S. Geol. Surv., Prof. Paper 59, p. 128, pl. 14, fig. 12, April 2, 1909; Weaver, Washington Geol. Surv., Bull. 15, p. 18, 1912.

Type specimen: In the U. S. National Museum, Cat. No. 154,088.

Type locality: Miller's Beach, Coos Bay, Oregon; Oligocene or lower Miocene.

Oligocene or *Miocene:* Miller's Beach, Coos Bay, Oregon (Dall); Blakeley formation, western Washington (Weaver, as lower Miocene).

This form looks very much like *M. indentata* Carpenter, judging from Dall's type figure, but it is larger. It is almost surely a synonym.

Macoma vanvlecki Arnold

Macoma vanvlecki Arnold, U. S. Geol. Surv., Bull. 396, p. 65, pl. 12, fig. 2, pl. 16, fig. 1, January 15, 1910; Bull. 398, pp. 110, 302, 310, pl. 34, fig. 2, pl. 38, fig. 1, 1910.

Type specimen: In the U. S. National Museum, Cat. No. 165,576.

Type locality: Fourteen miles southwest of Coalinga; Jacalitos formation, lower Pliocene.

Pliocene: Jacalitos formation of the Coalinga region (Arnold).

This form is probably a variety of *M. indentata.*

From the Jacalitos formation, lower Pliocene of the Coalinga region, Arnold reported and figured[1] a species presumably of *Macoma* which was so poorly represented that no specific name was assigned to it. Arnold's figure recalls *Taras parilis* (Conrad). "*Macoma kerica*" Hendrickson may be a synonym of *Cryptomya californica*, but the type material is poor.

Family SEMELIDAE

Genus SEMELE Schumacher, 1817

Semele Schumacher, Essai d'un Nouv. Syst. Habit. Vers Test., p. 165, 1817, only species *Tellina reticulata* Spengler; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 985, 1900; Woodring, Carnegie Inst., Publ. No. 366, p. 178, 1925.
Amphidesma Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 489, 1818; Bowdich, Elem. Conch., Pt. 2, p. 8, pl. 2, fig. 18, 1822.

Type (by monotypy), *Tellina reticulata* Spengler = *Tellina proficua* Pulteney; Caribbean; Recent.

This genus is most abundantly represented in the tropical and warm temperate seas. It dates back at least to the middle Eocene.

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[1] U. S. Geol. Surv., Bull. 396, p. 64, pl. 15, fig. 3, 1910.

Semele decisa (Conrad)

Plate 14, Figures 13*a*, 13*b*

Amphidesma decisa Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 234, pl. 19, fig. 2, 1837.

Semele decisa Conrad, Carpenter, Proc. Zool. Soc. London for 1856, p. 213, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 94, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 264, 1888; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 995, 1900; Baker, Nautilus, Vol. 16, p. 42, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 165, 1903; Dall, Proc. Acad. Nat. Sci. Phila., for 1915, p. 25; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 45, pl. 13, fig. 2, 1920; Dall, U. S. Nat. Mus.; Bull. 112, p. 48, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 179, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type locality: San Diego, California; Recent.

Pleistocene: Lower San Pedro series at San Pedro, rare; foot of Twenty-sixth Street, San Diego; common in the upper San Pedro series at Los Cerritos, but rarer in the same horizon at Deadman Island and San Pedro (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: San Pedro, California, to San Martin Island, Lower California, Mexico (Baker); Point Abreojos, Lower California (Hemphill Collection at Stanford University).

Semele flavescens (Gould)

Amphidesma flavescens Gould, Proc. Boston Soc. Nat. Hist., Vol. 4, p. 89, November, 1851.

Amphidesma proximum C. B. Adams, Ann. New York Lyceum Nat. Hist., Vol. 5, p. 513, 1852 (pagination of separate, p. 289).

Semele flavescens Gould, Dall, Proc. Acad. Nat. Sci. Phila. for 1915, p. 25; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 154, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Type locality: San Diego, California; Recent.

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).

Recent: San Pedro, California (in Oldroyd Collection at Stanford University), to Callao, Peru (Jordan); Scammons Lagoon, Lower California, Mexico (Hemphill Collection at Stanford University).

Semele rubropicta Dall

Semele rubropicta Dall, Amer. Journ. Conch., Vol. 7, p. 144, pl. 14, fig. 10, 1871; Arnold, U. S. Geol. Surv., Bull. 396, p. 156, pl. 25, fig. 3, Jan. 15, 1910; Bull. 398, pl. 47, same figure, 1910; Dall, Proc. Acad. Nat. Sci. Phila. for 1915, p. 26; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 254, 1916; Nomland, Vol. 10, p. 220, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 48, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 180, pl. 43, fig. 10, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the U. S. National Museum.

Type locality: Soquel, Monterey Bay, California; Recent.

Pliocene: Upper part of Etchegoin formation in Coalinga region, Fresno and Kings counties, California (Arnold, 1910; Nomland, 1917); Merced Pliocene of Sargent oil field, San Benito County (Martin).

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); lower Quaternary at Magdalena Bay and upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926).

Recent: Forrester Island, Alaska, to Tia Juana, Lower California, Mexico (Dall, 1921).

Semele fausta Nomland

Semele fausta Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 233, 234, pl. 9, figs. 3, 3*a*, 3*b*, 1917.

Type specimen: In the University of California collection, No. 11,102.

Type locality: On Zapato Creek, Fresno County; Etchegoin, Pliocene.

Pliocene: Rare and known only from the *Pecten coalingensis* zone of Coalinga district (Nomland).

"This form is of the same general type as *Semele rubropicta* Dall, from which it may be distinguished by its having a greater length in proportion to the width, the anterior portion being longer, the fold more nearly obsolete, and by the long, straight, anterior dorsal margin. The hinge also differs in having the weak, narrow resilifer and long, narrow laterals, this being especially true of the anterior teeth." (Nomland.)

Semele incongrua Carpenter

Semele incongrua Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 208, 1864; Dall, Proc. Acad. Nat. Sci. Phila. for 1915, p. 27; U. S. Nat. Mus., Bull. 112, p. 49, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 181, pl. 11, figs. 12, 13, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925.

Type specimen: In the University of California collection, No. 1,061.

Type locality: Santa Barbara, California; Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd).
Recent: Monterey, California, to the Coronados Islands, Lower California, Mexico (Dall, 1921).

Semele incongrua Carpenter variety **montereyi** Arnold

Semele pulchra Sowerby, var. *montereyi* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 166, pl. 15, figs. 3, 3*a* (not 4, 4*a*), 1903; Dall, Proc. Acad. Nat. Sci. Phila. for 1915, p. 27.

Type specimen: In the U. S. National Museum.

Type locality: Deadman Island, San Pedro Harbor; Pleistocene.

Pleistocene: Rare in lower San Pedro series at Deadman Island,[1] Los Angeles County (Arnold).

This appears to be a rare, extinct variety. Arnold originally reported it (on the authority of Dall) as living at Monterey, but the Recent form is the typical variety of *incongrua*.

Semele pulchra (Sowerby)

Amphidesma pulchrum Sowerby, Proc. Zool. Soc. London for 1832, p. 57; Conch. Illustr., *Amphidesma*, fig. 5, 1833.
Semele pulchra Sowerby, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 94, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 264, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 166, pl. 15, figs. 1, 1*a*, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 272, 1909; Proc. Acad. Nat. Sci. Phila. for 1915, p. 27; U. S. Nat. Mus., Bull. 112, p. 49, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 181, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: ? In the British Museum.

Type locality: Bay of Caracas, South America.

Pleistocene: Foot of Twenty-sixth Street, San Diego (Arnold); rather rare in the upper San Pedro series at San Pedro and Los Cerritos (Arnold); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California, to Ecuador (Dall, 1921).

Semele quentinensis Dall

Semele quentinensis Dall, West American Scientist, Vol. 19, No. 3, p. 22, June 15, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 26, pl. 8, fig. 4, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimen: In the U. S. National Museum.

Type locality: San Quintin Bay, west coast of Lower California, Mexico; Pleistocene (upper Pleistocene, according to Jordan).

Pleistocene: At the type locality.

Genus CUMINGIA Sowerby, 1833

Cumingia Sowerby, Proc. Zool. Soc. London, Pt. 1, p. 34, May, 1833; Gray, Pt. 15, p. 187, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 998, 999, 1900.

Type (by subsequent designation, Gray, 1847), *Cumingia lamellosa* Sowerby, Pacific coasts of North, Central, and South America.

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[1] About two years ago, Deadman Island was removed in the course of harbor improvement. Representative collections of fossil mollusks from this classic locality are to be found at Stanford University, at the California Academy of Sciences, at the Los Angeles Museum, at the California Institute of Technology, and at the San Diego Society of Natural History.

Cumingia lamellosa Sowerby

Plate 14, Figure 23; Plate 19, Figure 1

Cumingia lamellosa Sowerby, Proc. Zool. Soc. London, Pt. 1, p. 34, May, 1833; Conch. Icon., Vol. 19, *Cumingia*, pl. 1, fig. 5, 1873; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1001, 1900; Proc. U. S. Nat. Mus., Vol. 37, p. 272, 1909; E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2 (p. 42), 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 49, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 182, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 253, 255, 1929.
Cumingia trigonularis Sowerby, *op. cit.*, p. 34, 1833.
Cumingia californica Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 234, pl. 17, fig. 12, 1837; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 94, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 238, 1888; Keep, West Coast Shells, p. 196, fig. 168, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 186, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 1001, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 167, 1903.

Type specimens: Of *lamellosa*, in the British Museum; of *californica*, in the Academy of Natural Sciences, Philadelphia ?.

Type localities: Of *lamellosa*, Chile; of *californica*, near Santa Barbara.

Pleistocene: Santa Barbara (Cooper, possibly upper Pliocene); "Pliocene" of Deadman Island (collection at Stanford University); lower San Pedro series of Deadman Island, Crawfish George's, and San Pedro (Arnold); lower San Pedro fauna of Nob Hill cut at San Pedro (T. S. Oldroyd); San Diego (Cooper); at the entrance to the abandoned coal mine and other nearby localities on Point Loma and at Torrey Pines, San Diego County (F. Stephens); at the "Chiton bed" on Point Firmin, Los Angeles County (E. P. and E. M. Chace); Todos Santos Bay, Lower California, Mexico (Dall, 1900).
Recent: Crescent City, California, south to Payta, Peru (Dall), and to Chile (Sowerby).

Cumingia densilineata Dall

Cumingia densilineata Dall, West American Scientist, Vol. 19, No. 3, p. 22, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 15, pl. 8, fig. 5, pl. 11, fig. 2, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, pp. 245, 248, pl. 25, figs. 1, 3, 5, 1926.

Type specimen: In the U. S. National Museum.

Type locality: San Quintin Bay, west coast of Lower California, Mexico; Pleistocene.

Pleistocene: Upper Pleistocene at the type locality (Jordan).

Family DONACIDAE

Genus DONAX Linnæus, 1758

Donax Linnæus, Syst. Nat., Ed. 10, p. 682, 1758; Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 48, 144, 1817; Children, Quart. Jour. Sci., Lit., and Arts, p. 308, January, 1823; Herrmannsen, Indicis Gen. Malac., Vol. 1, pp. 402-404, 1847; Gray, Proc. Zool. Soc. London, Pt. 15, p. 187, 1847; H. and A. Adams, Gen. Rec. Moll., Vol. 2, pp. 403, 404, 1856; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 133, 1871; Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, Vol. 4, pp. 77-79, 1881; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 964-966, 1900; Woodring, Carnegie Inst., Publ. No. 366, pp. 180, 181, 1925.
Chion Scopoli, Introductio ad Historiam Naturalem, p. 398, 1777, only species, "*Donax denticulata* Linn."

Type (by subsequent designation, Herrmannsen, Apr. 18, 1847, and Gray, Nov., 1847), *Donax rugosus* Linnæus; West Indies; Recent.

The genus *Donax* comprises small, equivalved, often wedge-shaped shells (shells with the outline of a right or obtuse-angled triangle), which generally occur on sandy beaches in tropical and temperate regions. The shells are small, strong, without epidermis, and are sometimes much shorter posteriorly than anteriorly. Some species are trigonal in shape, with high umbones, while a few are elongate and somewhat Modioliform. The genus has a complex synonymy, which is partly elucidated by Dall in the reference given above. Herrmannsen designated *Donax rugosus* as the type of the genus *Donax* restricted by Schumacher. It matters not whether the application of this designation to the Linnæan conception of the genus be accepted or not, for one year later Gray designated the same type, applying it specifically to *Donax* Linnæus. Children's type designation is invalid because the species designated, *Donax scortum* (Linnæus), was not in the original list of species of *Donax*, being described as a *Venus*. In Lamarck's "Prodrome," *Donax trunculus* is given as an example, and although this does not constitute type designation, many writers have considered it as such.

Section Serrula Chemnitz in Mörch, 1853

Serrula Chemnitz, Mörch, Cat. Yoldi, Pt. 2, p. 18, 1853, including *D. trunculus* Linnæus; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 405, 1856; Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, Vol. 4, p. 86, 1881; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 965, 1900, type, "*D. trunculus* (L.) Hanley," in syn. of *Donax*, *s. l.*

Type (by subsequent designation, Dall, 1900), *D. trunculus* Linnæus; figured in Reeve's Conch. Icon., Vol. 8, *Donax*, pl. 4, figs. *23a-b*, 1854; European seas.

Shell ovate-triangular, wedge-shaped, gibbous anteriorly; margin of valves strongly denticulated. Hinge with the cartilage-fissure oblong. (H. and A. Adams.)

Serrula was used by Chemnitz,[1] but not in a definitely generic sense. The name can date from Mörch, who used it in classifying the Yoldi collection. Dall designated the type in 1900.[2]

The California species of *Donax* have been in a state of confusion for years, but in a recent paper, Strong[3] has done much to clarify the situation.

Donax californicus Conrad

Donax californica Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 254, pl. 19, fig. 21, 1837; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 968, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 170, pl. 13, fig. 9, 1903; Keep, West American Shells, p. 88, 1911; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 47, pl. 16, fig. 1, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 49, 1921; Strong, Nautilus, Vol. 37, p. 83, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 183, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; not *D. californicus* Conrad, of Carpenter, 1864, Cooper, 1888, Keep, 1888, 1892, nor of Williamson, 1892, which = *D. gouldii* Dall, 1921.

Donax navicula Sowerby, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864, not of Sowerby, 1854.

Donax californicus Conrad, Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Vol. 6, p. 92, 1881.

"*Donax flexuosus* Gould," Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 238, 1888; Keep, West Coast Shells, p. 192, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 186, 1892; not of Gould, Boston Journ. Nat. Hist., Vol. 6, p. 394, pl. 15, fig. 8, 1857, which = *D. striatus* Linnæus, 1759, West Indies.

Shell elongated, somewhat pointed at both extremities; discs with very minute radiating lines; color yellowish, obscurely rayed; a brown stripe on the anterior and posterior submargin; within white and purplish brown; margin beautifully crenulated. (Conrad, 1837.)

Type locality: Near Santa Barbara; Recent.

Pleistocene: Santa Barbara to San Diego (Cooper); lower San Pedro series at Deadman Island and San Pedro, rare (Arnold); lower San Pedro of Nob Hill cut at San Pedro (T. S. Oldroyd); upper San Pedro series at San Pedro (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Santa Barbara, California, to Panama (I. S. Oldroyd).

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[1] Neues Syst. Conchyl. Cab., Vol. 6, p. 254, 1782.

[2] In the synonymy of *Donax*, Dall gives "*Serrula* Mörch, Cat. Yoldi, ii., p. 18, 1853. Type *D. trunculus* (L.) Hanley." Since Mörch, in his catalogue referred to, made no mention of type, and none was constituted by monotypy, we have taken Dall's statement as a type designation. Dall designated many types in this manner, although some of these designations are invalid for obvious reasons. In his "Revision des Donacidées," Bertin used *Serrula* Chemnitz for *D. trunculus* and several other species, but he did not mention any type for the group.

[3] Nautilus, Vol. 37, pp. 81-84, 1924.

This is the elongate, pointed *Donax* of southern California beaches. It is very different from the short, square-ended species, *D. gouldii* Dall. *D. flexuosus* Gould is a short, trigonal species very unlike either of the above, and it has been assumed that an error in locality accounts for Gould's attributing it to Santa Barbara. It may be a synonym of *D. striatus* Linnæus, of the West Indies. *Donax navicula* Sowerby, which was confused with *californicus* by Carpenter, is somewhat elongate, but the posterior end is slightly constricted, giving it an almost beaked appearance. It is a southern shell. *Donax punctatostriatus* Hanley is a much larger shell of the Lower California coast.

Donax gouldii Dall

Plate 13, Figure 12

Donax obesus Gould, Proc. Boston Soc. Nat. Hist., Vol. 4, p. 90, November, 1851; Boston Journ. Nat. Hist., Vol. 6, pp. 394, 395, pl. 15, fig. 9, 1853; not *Donax obesa* d'Orbigny, Voy. Amer. Mérid., Moll., 1846.

Donax lævigata Deshayes, Proc. Zool. Soc. London for 1854, p. 352; Reeve, Conch. Icon., Vol. 8, *Donax*, pl. 5, fig. 31, 1854; Sowerby, Thes. Conch., Vol. 3, *Donax*, p. 309, figs. 30-32, 1866; Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Vol. 4, p. 91, 1881; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 969, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 170, pl. 13, fig. 8, 1903; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 47, pl. 16, fig. 2, 1920; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 252, 253, 254, 255, 1929; not *Donax lævigata* Gmelin, Syst. Nat., Ed. 13, p. 3265, 1791.

"*Donax californicus* Conrad," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 238, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 186, 1892; not *Donax californica* Conrad.

Donax gouldii Dall, U. S. Nat. Mus., Bull. 112, p. 49, February 24, 1921; Strong, Nautilus, Vol. 37, p. 83, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 183, pl. 49, figs. 8, 9, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Shell small, smooth, short, rather abruptly truncated posteriorly, margins of valves finely crenulated. Length, 15 to 20 mm.; height, 10 to 14 mm.

Type localities: Of *obesus* Gould, San Diego, Recent; of *lævigatus* Deshayes, unknown; of *gouldii*, Dall, presumably California; Recent.

Pleistocene: Lower San Pedro series at San Pedro and Deadman Island, rare; Barlow's Ranch, near Ventura (Arnold); "Saugus" near Ventura (Waterfall); Pleistocene of Spanish Bight, Crown Point or Bay Point, Pacific Beach, and Torrey Pines, San Diego (Frank Stephens); foot of Twenty-sixth Street, San Diego; common in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, Long Beach, and Deadman Island, Los Angeles County (Arnold).

Recent: Santa Barbara, California, to Acapulco, Mexico (Dall, 1921).

This is the common, small, square-ended species of southern California beaches. It has a very restricted habitat between tides, occurring in a narrow zone on the clean sandy beaches where it may be gathered by the thousands during low and mid-tide.

Gould's specific name *obesus* had been used by d'Orbigny in 1846. Although the habitat of *Donax lævigatus* Deshayes was not given when described, the figure in the Conchologia Iconica suggests that the name was applied to the present California species. However, the name was used by Gmelin in 1791 for an entirely different shell from Madras, India (Tranquebar). This latter species is figured by Chemnitz.[1] *Donax californicus* Conrad, confused by Carpenter, Cooper, and others (but not by Arnold) with the present species is very distinct. While we have not seen the type specimens of these species, the type figures or authentic illustrations indicate a significant difference. It is not unlikely that a name older than *gouldii* can be found for this species.

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[1] Neues Syst. Conch. Cab., Vol. 6, p. 253, pl. 25, fig. 249, 1782.

Donax punctatostriatus Hanley

Donax punctatostriatus Hanley, Proc. Zool. Soc. London for 1843, p. 5, 1843; Rec. Shells, p. 84, pl. 14, fig. 24, 1844; Reeve, Conch. Icon., Vol. 8, *Donax*, pl. 3, fig. 16, 1854; Sowerby, Thes. Conch., Vol. 3, *Donax*, p. 310, sp. 33, figs. 49, 50, 1866; Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, Vol. 4, p. 95, 1881.

Donax punctatostriata Hanley, Dall, U. S. Nat. Mus., Bull. 112, p. 49, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Shell large, obliquely triangular with rather sharp angles; radially striate.

Type locality: Mazatlan, Mexico; Recent.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Lower California, Mexico, to Peru.

It is probable that this species does not extend so far north as San Pedro, California, which was given as the northern limit by Dall.

Donax conradi Deshayes

Donax conradi Deshayes, Proc. Zool. Soc. London for 1854, p. 351; Reeve, Conch. Icon., Vol. 8, *Donax*, pl. 5, fig. 29, 1854; Sowerby, Thes. Conch., Vol. 3, *Donax*, p. 310, sp. 34, fig. 51, 1866; Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, Vol. 4, p. 92, 1881; Dall, U. S. Nat. Mus., Bull. 112, p. 49, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 184, 1924.

"*Donax contusus* Reeve," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 241, etc., 1864, doubtfully of Reeve, Conch. Icon., Vol. 8, *Donax*, pl. 4, fig. 24, 1854, Mazatlan.

"*Donax culter* Hanley," Carpenter, *op. cit.*, 1864, not, or doubtfully, of Hanley, Proc. Zool. Soc. London for 1845, p. 14, 1845.

Shell large, radially striate, somewhat like that of *D. punctatostriatus* Hanley, but more elongate. Length, 27 mm.; height, 17 mm.

Type locality: Gulf of California; Recent.

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Jordan).
Recent: San Diego, California, to Central America (Dall).

Family SANGUINOLARIIDAE

Genus GARI Schumacher, 1817

Gari Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 44, 131, 1817; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 461, 1846; H. and A. Adams, Gen. Rec. Moll., Vol. 2, pp. 389, 390, 1856; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Vol. 3, p. 113, 1871; Bertin, "Revision des Garidées," Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, Vol. 3, p. 103, 1880; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 377, 1897.

Psammobia Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 511, 1818; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 478, 1895; Dall, Proc. Acad. Nat. Sci. Phila., p. 57, 1898; Trans. Wagner Inst. Sci., Vol. 3, pp. 972, 974, 1900.

Type (by absolute tautonymy), *Gari vulgaris* Schumacher (= "*Tellina*" *gari* Linnæus, Spengler = "*Psammobia*" *cærulescens* Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 513, 1818, at least in part; Reeve, Conch. Icon., Vol. 10, *Psammobia*, sp. 60, 1857); East Indies, Philippines, Orient.

Shell elongate-ovate, generally rather thin, equivalve; hinge with one or two bifid teeth in each valve, part or all of one or more teeth sometimes being obsolete or much reduced; pallial sinus large; sculpture absent or of moderate strength, radial or concentric.

As Schumacher's name *Gari* has priority over *Psammobia* Lamarck, 1818, the latter must be considered a synonym. Schumacher included but two species in the original list of species of *Gari*, the first, which he figured (pl. 9, fig. 2), being *Gari vulgaris*, a new name for "*Tellina gari* Lin. Spengl. [Nat. Hist. Selsk. Skr.] 4. H. 2, pag. 70, No. 1, Chemn.

[Neues Syst. Conchyl. Cab. Vol.] 6, pag. 100, Tab. 10, fig. 92. 93.''[1] The other species, *Gari papyracea* (not figured by Schumacher), attributed to Spengler, is a *Tellina* and need not be considered here. The specific name ''*gari*,'' although appearing in the synonymy, makes the first species ''type by absolute tautonymy.'' In 1758, Linnæus described a *Tellina gari*, taking the name from Rumphius's use of it in 1704. This *Tellina gari* Linnæus, 1758, is obscured in doubt, as pointed out by Bertin[2] and others. Dall[3] assumed that the *T. gari* Linnæus of Schumacher was not the *gari* of Linnæus, 1758, but of Linnæus, 1762 (? Syst. Nat., Ed. 11).[4] Fortunately, Schumacher's reference to Chemnitz settles the uncertainty, for although the latter author (*op. cit.*, p. 101) figures two different species (pl. 10, figs. 92, 93), he states that figure 92 represents *Tellina gari* Linnæus from Spengler's collection, which unquestionably was the one Schumacher had in mind when he referred to Spengler. From a careful comparison of the figure given by Schumacher with Chemnitz's figure 92 and specimens of *Gari cærulescens* (Lamarck) from the Philippines, we feel confident that the latter species was the one figured by Schumacher (pl. 9, fig. 2), and by Chemnitz in figure 92. Schumacher's figure is only of the interior, but it exactly matches specimens of *cærulescens*, except that the figure represents a slightly larger, more mature individual than any of the specimens we have examined. Chemnitz's figure 93 is almost certainly *Gari amethysta* (Wood) (described as *Solen amethystus*).[5]

Section Gobraeus Leach, 1852

Gari californica (Conrad)

Psammobia californica Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 4, p. 121, 1849 (figured in the Journal, Vol. 7, pl. 19, fig. 3, 1837, without name or description); Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 45, pl. 14, fig. 1, 1920.

Sanguinolaria rubro-radiata Conrad, Carpenter, Proc. Zool. Soc. London, Pt. 24, p. 212, 1856.

Sanguinolaria rubroradiata Conrad, Nutt. MS., Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 195, 1857.

Psammobia rubroradiata Nuttall, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 540, 563, 602, 638, 1864.

Psammobia rubroradiata (Nutt. MS.), Carpenter, Proc. Acad. Nat. Sci. Phila. for 1865-66, p. 55.

Gobræus californicus Conrad, Dall, Acad. Nat. Sci., Phila., Proc. for 1898, p. 58; U. S. Nat. Mus., Bull. 112, p. 49, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 7, 1925.

Psammobia (*Gobræus*) *californica* Conrad, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 185, pl. 43, fig. 5, 1924.

Type locality: California; Recent.

Pliocene: Elsmere Canyon, Los Angeles County (one specimen in collection of Los Angeles Museum).
Pleistocene: Lower San Pedro fauna of Nob Hill cut at San Pedro (T. S. Oldroyd).
Recent: Japan, Kamchatka, the Aleutian Islands and south to San Diego, California (Dall, 1921).

Psammobia rubroradiata Carpenter is apparently a synonym of *Gari californica* (Conrad). A careful search of the literature convinces us that Conrad never described a *rubroradiata* in this genus. Carpenter gave a brief description of it in 1864 (p. 638) and an ample diagnosis in 1865 (or 1866). *Gari californica* (Conrad) probably ranges south of San Diego in deeper water.

Gari edentula (Gabb)

Plate 21, Figure 5

''*? Siliquaria*'' *edentula* Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 53, pl. 15, fig. 11, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 264, 1888.

Gobræus edentulus Gabb, Dall, Acad. Nat. Sci. Phila., Proc. for 1898, p. 58; U. S. Nat. Mus., Bull. 112, p. 49, 1921.

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[1] The quotation marks include matter from Schumacher *verbatim;* the brackets include added data.

[2] *Op. cit.*, p. 112, 1880.

[3] *Op. cit.*, p. 970, 1900.

[4] Dall gives "Linné, 1762" probably referring to the 11th edition, which we have not been able to consult. Bertin gives a reference to the 12th edition, 1768.

[5] Gen. Conch., p. 138, pl. 34, fig. 1, 1815.

Psammobia (*Psammobia*) *edentula* Gabb, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 168, 1903.
Psammobia edentula Gabb, English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Nomland, Vol. 10, pp. 220, 301, 1917.
Psammobia (*Gobræus*) *edentula* Gabb, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 185, pl. 57, fig. 1, 1924.

Type locality: San Fernando, Los Angeles County; Pliocene.

Miocene: Santa Margarita formation, upper Miocene, of middle California, questionably identified (Nomland).
Pliocene: Lower Fernando, lower Pliocene, of Holser Canyon, Los Angeles County (English); San Fernando (Gabb; Cooper); lower Fernando (Nomland).
Pleistocene: Upper San Pedro series of San Pedro, rare, three good specimens (Arnold).
Recent: San Pedro and Catalina Island to San Diego, California (Dall, 1921).

This species is larger and more elongate than *G. californica* Conrad.

Genus SANGUINOLARIA Lamarck, 1799

Sanguinolaria Lamarck, Prodrome, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 84, 1799, only species *Solen sanguinolentus* Gmelin; Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, Vol. 3, pp. 81-83, 1880; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 972, 978, 1900.
Loboria Schumacher, Ess. Nouv. Syst. Hab. Vers Test., p. 122, 1817.

Type (by monotypy), *Solen sanguinolentus* Gmelin;[1] Antilles; Recent.

Section NUTTALLIA Dall, 1898

Sanguinolaria nuttallii Conrad

Plate 20, Figures 15*a*, 15*b*

Sanguinolaria nuttallii Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 230, pl. 17, fig. 6, 1837; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 638, 1864; Keep, West Coast Shells, p. 198, fig. 170, 1888, 1892; Dall, Proc. Acad. Nat. Sci. Phila. for 1898, p. 58; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, 1915; Nomland, Vol. 10, p. 220, 1917; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 46, pl. 14, figs. 2, 3, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 50, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 185, pl. 55, figs. 1, 4, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925.
Psammobia decora Hinds, Ann. Mag. Nat. Hist., Vol. 10, p. 81, pl. 6, fig. 1, October, 1842; Zool. Voy. Sulphur, Moll., p. 66, pl. 19, figs. 6, 7, 1844.
Hiatula nuttallii Conrad sp., Bertin, Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, Vol. 3, p. 90, 1880.
Sanguinolaria (*Nuttallia*) *nuttallii* Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 168, 1903.
Sanguinolaria (*Nuttallia*) *orcutti* Dall, West American Scientist (San Diego), Vol. 19, no. 2, p. 17, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 26, pl. 12, figs. 1, 2, 1925.
Sanguinolaria orcutti Dall, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, pp. 244, 249, 250, text fig. 1, 1926.

Type specimens: Of *nuttallii*, location unknown to us; of *orcutti*, in U. S. National Museum, No. 333,118.

Type localities: Of *nuttallii* and *decora*, San Diego, California, Recent; of *orcutti*, San Quintin Bay, Lower California, Mexico, Pleistocene.

Miocene: Upper part of San Pablo formation, upper Miocene of middle California (Clark).
Pliocene: Etchegoin (Clark); rare in the *Pecten coalingensis* zone, Etchegoin formation of the Coalinga region (Nomland).
Pleistocene: Lower San Pedro fauna of Nob Hill cut at San Pedro, not rare (T. S. Oldroyd); San Quintin Bay, Lower California, Mexico, as *orcutti* (Dall; Jordan); rather rare in the upper San Pedro series at San Pedro and Los Cerritos (Arnold).
Recent: San Pedro, California, to Magdalena Bay, Lower California, Mexico; questionably Japan (Dall, 1921).

This is the type of the Section *Nuttallia* Dall.

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[1] Syst. Nat., Ed. 13, p. 3227, 1788; figured by Reeve, Conch. Icon., Vol. 10, *Sanguinolaria*, pl. 1, fig. 4, 1857. Bertin, *op. cit.*, p. 83, gives the synonymy and a discussion of this species. *Solen fucatus* Spengler, the type of *Loboria* Schumacher, is a synonym of *S. sanguinolentus* Gmelin, making Schumacher's genus an exact synonym of Lamarck's.

Sanguinolaria orcutti Dall is not specifically distinct from *nuttallii.* The supposed differences in size and development of the anterior cardinal tooth do not occur in such a way as to suggest a valid difference. Dall's form has been reported abundant in the upper Pleistocene throughout the deposit at San Quintin Bay.

In the upper Miocene of California *Sanguinolaria alata* (Gabb) is reported.[1] *Sanguinolaria townsendensis* Clark[2] was described from the Oligocene of Washington.

Genus TAGELUS Gray, 1847

Tagelus Gray, Proc. Zool. Soc. London, Pt. 15, p. 189, 1847; Dall, Proc. Acad. Nat. Sci. Phila. for 1898, p. 59; Trans. Wagner Inst. Sci., Vol. 3, pp. 981, 982, 1900.

Type (by original designation), *Solen guinensis* Gray, figured in Reeve, Conch. Icon., Vol. 19, *Solen*, sp. 15, pl. 4, fig. 15, 1874, Guinea, west coast of Africa; Recent.

Beaks median or sub-posterior; teeth two in each valve, simple, pedunculate; valves without constriction or clavicle, straight; pallial sinus deep, reaching to or beyond the beaks; posterior adductor scar rounded; pallial sinus with the ventral part partially coalescent with the pallial line; *situs* estuarine or marine (Dall, 1900).

Tagelus Gray has a number of synonyms which have been given by Dall (1900) and need not be repeated here. The anatomy has been described by Bloomer.[3]

Tagelus californianus (Conrad)

Plate 21, Figures 2*a*, 2*b*, 3

Solecurtus (*Cultellus*) *californianus* Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 233, pl. 18, fig. 3, 1837.

Solecurtus californianus Conrad, Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 296, 1874; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 265, 1888; Keep, West Coast Shells, p. 201, fig. 172, 1888, 1892.

Tagelus californianus Conrad, Dall, Acad. Nat. Sci. Phila., Proc. for 1898, p. 59; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 169, 1903; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 48, pl. 15, fig. 1, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 50, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 149, 152, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 186, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 479, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 251, 255, 1929.

Tagelus californicus Conrad, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: Coyote Mountain, western Imperial County (Hanna); San Diego well, Balboa Park, San Diego (Dall, 1874).

Pleistocene: Santa Barbara; San Pedro; San Diego (Cooper); lower San Pedro series at Deadman Island and San Pedro, rare (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); "Saugus" near Ventura (Waterfall); upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, San Pedro, and Long Beach, common (Arnold); foot of Twenty-sixth Street, San Diego (Arnold; Stephens); also two miles north of Del Mar, San Diego County (Stephens); upper Quaternary of Scammons Lagoon, Lower California, Mexico (Jordan).

Recent: Santa Barbara, California, to Gulf of Tehuantepec (Dall).

Tagelus violascens (Carpenter)

Solecurtus violascens Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 27, footnote, 1857.

Tagelus violascens Carpenter, Dall, Acad. Nat. Sci. Phila. for 1898, p. 59.

Tagelus violacens Carpenter, Dall, Nautilus, Vol. 32, p. 24, 1918.

Type specimen: In the British Museum.

Type locality: Southwest Mexico.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918).

Recent: Gulf of California to Nicaragua (Dall, 1898).

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[1] Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 476, 477, pl. 61, fig. 14, pl. 62, fig. 5, 1915.

[2] Univ. Calif. Publ. Geol., Vol. 15, p. 97, pl. 18, fig. 7, 1924.

[3] Proc. Malac. Soc. London, Vol. 7, pp. 218-223, pl. 19, 1907.

Section Mesopleura Conrad, 1867

Mesopleura Conrad, "Cat. *Solenidæ*" Amer. Journ. Conch., Vol. 3, Appendix, p. 23, 1867, *Solen divisius* Spengler; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 984, 1900.

Shell with an internal radial rib, ventrally directed from the submedian beaks; ends of the valves rounded, and the form of the shell usually more or less arcuate; otherwise, like *Tagelus*. (Dall, 1900.)

Tagelus subteres (Conrad)

Solecurtus (*Cultellus*) *subteres* Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 233, pl. 17, fig. 10, 1837.

Tagelus subteres Conrad, Dall, Acad. Nat. Sci. Phila., Proc. for 1898, p. 60; U. S. Nat. Mus., Bull. 112, p. 50, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. I, p. 187, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type locality: Near Santa Barbara, California.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Santa Barbara, California, to Panama (Dall, 1921).

Superfamily Solenacea

Family SOLENIDAE

Genus SOLEN Linnæus, 1758

Solen Linnæus, Syst. Nat., Ed. 10, p. 672, 1758; Children, Quart. Journ. Sci., Lit., and Arts, p. 83, pl. 4, fig. 26, Oct., 1822; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 949, 951, 1900.

Type (by subsequent designation, Children, 1822), *Solen vagina* Linnæus.

Shell long, approximately straight, dorsal and ventral margins parallel, beaks anterior, valves gaping at each end; hinge with one cardinal in each valve.

Solen sicarius Gould

Plate 21, Figure 4

Solen sicarius Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 214, 1850; U. S. Expl. Exped. (Wilkes), Vol. 12, p. 287, 1852, Atlas, fig. 501, 1856; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 265, 1888; Keep, West Coast Shells, p. 202, fig. 173, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 172, 1903; Arnold, U. S. Geol. Surv., Bull. 396, p. 164, pl. 29, fig. 4, Jan. 15, 1910; Bull. 398, pl. 51, same figure, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 493, 494, 1913; English, Univ. Calif. Publ. Geol., Vol. 8, pp. 209, 211, 214, 1914; Clark, Vol. 8, p. 420, 1915; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 229, 1916; Nomland, Vol. 10, p. 220, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 281, pl. 26, fig. 1, pl. 50, 1918; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 50, pl. 15, fig. 2, 1920; Dall, U. S. Nat. Mus. Bull. 112, p. 50, 1921; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. I, p. 188, pl. 49, fig. 1, pl. 18, fig. 1, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type locality: Strait of Juan de Fuca; Recent.

Miocene: Montesano formation of western Washington (Weaver); ? Empire formation of Coos Bay region, Oregon; San Pablo formation, upper Miocene, of middle California (Clark); Walnut Creek, Contra Costa County (Cooper); Santa Margarita formation (Arnold).

Pliocene: Lower Merced; Purisima; Etchegoin Pliocene (Martin; Nomland; etc.); upper Wildcat formation of northern California (Martin); Merced formation of Sonoma County (Dickerson); Twelve Mile Creek, San Mateo County; also San Fernando, Los Angeles County (Cooper); lower Fernando of Elsmere, Holser, and Pico canyons, and east of mouth of Little Tujunga Canyon (English); Pico near Ventura (Waterfall).

Pleistocene: "Pliocene" of Deadman Island and Timm's Point, and common in the lower San Pedro series of Deadman Island and San Pedro (Arnold, 1903); Nob Hill cut, San Pedro (T. S. Oldroyd); "Saugus" near Ventura (Waterfall); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro at Los Cerritos, San Pedro, Crawfish George's, and Deadman Island, rare (Arnold, 1903); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Vancouver Island, British Columbia, to San Quintin Bay, Lower California, Mexico (Dall, 1921).

Professor B. L. Clark of the University of California states that the reports of the occurrence of *S. sicarius* in the Miocene and Pliocene undoubtedly refer to the variety *perrini*, but as the collections upon which many of the records have been based are not now available, we have merely tabulated the data as published, until a careful review of the Pacific coast species of this genus can be made.

Solen sicarius Conrad variety **perrini** Clark

Solen perrini Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 420, 477, 478, pl. 44, fig. 2, 1915; Nomland, Vol. 10, p. 301, 1917.

Type specimen: In the University of California collection.

Type locality: Middle California; San Pablo group, upper Miocene.

Miocene: Scutella breweriana zone, Briones formation, lower part of upper Miocene; San Pablo group and Santa Margarita formation, upper Miocene, middle California (Clark); Santa Margarita formation north of Coalinga (Nomland).
Pliocene: Jacalitos and Etchegoin formations (Clark).

According to Clark: "This species sometimes has a length of six to eight inches and a height of from one inch to one and one-half inches. It is the most common *Solen* in the Miocene and Pliocene of California. It has been listed by various writers as *Solen sicareus* Gould and *Solen rosaceus* Cpr. It differs from *S. sicareus* in that both the posterior dorsal edge and the ventral edge are straight. *S. sicareus* shows a slight concavity along the posterior dorsal edge, while the ventral edge is slightly convex. Also *S. sicareus* has very little, if any, flexure on the anterior end. *S. perrini* resembles *S. rosaceus* more closely than *S. sicareus*. It differs in that it is a heavier shell; and it is higher in proportion to its length."

Solen rosaceus Carpenter

Solen (*sicarius* ? var.) *rosaceus* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 638, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 177, 1865.

Solen rosaceus Carpenter, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 88, 1868-9; Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 296, 1874; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 265, 1888; Dall, Proc. U. S. Nat. Mus., Vol. 22, p. 108, 1899; Trans. Wagner Inst. Sci., Vol. 3, p. 952, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 38, 171, 1903; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 50, pl. 15, fig. 3, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 50, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 188, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Miocene: Tomales, Marin County; Martinez, Contra Costa County (Cooper).
Pliocene: Santa Rosa, Sonoma County; San Ramon, Kirker's Pass, Contra Costa County; San Fernando, Los Angeles County; San Diego well (Cooper); San Diego well in Balboa Park, San Diego (Dall).
Pleistocene: Santa Barbara (Cooper); rare in lower San Pedro series of Deadman Island and San Pedro bluffs; Spanish Bight, San Diego; rare in the upper San Pedro of Deadman Island and Crawfish George's (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Barbara, California, to the Gulf of California, Mexico (Dall, 1921).

This species is longer, narrower, more nearly cylindrical, and has a more rounded anterior extremity than *S. sicarius* Gould.

Genus **SILIQUA** Megerle von Mühlfeld, 1811

Siliqua Megerle von Mühlfeld, Gesellschaft Naturforschender Freunde, Magazin, p. 44, 1811; Gray, Proc. Zool. Soc. London, p. 189, 1847; Herrmannsen, Indicis Gen. Malac., Vol. 2, p. 454, Feb. 18, 1848; Dall, Proc. U. S. Nat. Mus., Vol. 22, p. 108, 1899; Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 955, 1900.

Leguminaria Schumacher, Ess. Nouv. Syst. Hab. Vers Test., p. 126, 1817, type (by monotypy) *L. costata* Schumacher, pl. 7, fig. 1, = *S. radiata* (Linnæus).

Machæra Gould, Invert. Mass., p. 32, 1841, not *Machæra* Cuvier, 1832.

Type (according to Gray, Herrmannsen, Dall, etc.), *Solen radiatus* Linnæus, Syst. Nat., Ed. 10, p. 673, 1758, illustrated by Sowerby in Reeve, Conch. Icon., Vol. 19, *Cultellus*, pl. 4, species 13, 1874, living, Sumatra.

Shell of medium or large size, relatively thin, almost flat, elongate, with nearly parallel margins and rounded ends; marked by concentric growth lines and annular rings, and usually with broad, radiating color bars; hinge usually about a third of the distance from the anterior end, left hinge with two small sharp cardinal teeth close together and with one and the remnants of a second spur-like posterior tooth, right hinge with one sharp cardinal tooth and one thin wedge-like posterior tooth; posterior dorsal margins strongly reinforced under the areas of attachment of the ligament, behind which they are abruptly slit as in *Macoma secta;* interior of each valve marked by a transverse strengthening rib that runs from the hinge toward the ventral margin a little in front of the vertical, dying out gradually before it reaches the margin, pallial sinus large, rounded, reaching from the posterior quarter about to the middle of the shell.

Geologic range: Cretaceous to Recent (Pacific United States).

Distribution: Arctic and temperate regions generally, although the type comes from Sumatra.

This well-marked genus is like *Cultellus* except that the latter lacks the internal rib. It is distinguished from other genera in the *Solenidæ* by the presence of this internal rib, and usually also from *Solen*, *Ensis*, and *Tagelus* by its deeper shell. Iredale has shown that *Solecurtus* Blainville is not a synonym but takes the place of *Psammosolen*.

Siliqua patula (Dixon)

Cf. Plate 21, Figure 9

Solen patulus Dixon, Voyage Round the World, p. 355, figs. 2, 1789.
Solen maximus Wood, General Conchology, Vol. 1, p. 129, pl. 31, fig. 3, 1815, not of Gmelin, 1792.
Solen gigas Dillwyn, Cat. Shells, p. 61, 1817.
Solecurtus nuttallii Conrad, Journ. Acad. Nat. Sci., Vol. 7, p. 232, pl. 17, fig. 9, 1837.
Siliqua splendens Chenu, 1845 (*fide* Dall); Chenu, Man. Conchyl., Vol. 2, p. 23, fig. 103, 1862.
? Siliqua americana Chenu, 1845 (questionably referred here by Dall).
Siliqua grandis "Gmelin," Dunker, Carpenter, etc. (*fide* Dall); there is no *grandis* of Gmelin.
Machæra patula Dixon, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 601, 638, etc., 1864, reprinted, Smithsonian Inst. Misc. Coll. No. 252, pp. 87, 124, etc., 1872; Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 89, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 248, 1888; Keep, West Coast Shells, p. 201, fig. 171, 1888, 1892.
Siliqua californica Conrad, Amer. Journ. Conch., Vol. 3, p. 193, 1867 (*fide* Gabb).
Siliqua patula Dixon, Conrad, Amer. Journ. Conch., Vol. 3, Appendix, p. 25, 1868; Dall, Amer. Journ. Conch., Vol. 7, p. 140, 1871; Proc. U. S. Nat. Mus., Vol. 22, p. 109, 1899; Keep, West Amer. Shells, p. 92, fig. 82, 1904; Bloomer, Proc. Malac. Soc. London, Vol. 6, pp. 193-195 (anatomy), pl. 12, 1905; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 254, 1916; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 50, pl. 15, fig. 4, 1920; Dall, Bull. 112, U. S. Nat. Mus., p. 51, 1921; Meek, Univ. Calif. Publ. Geol., Vol. 14, pp. 414, 418, 1923; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 190, pl. 48, pl. 52, fig. 1, 1924.
Cultellus nuttali Conrad, Sowerby in Reeve, Conch. Icon., Vol. 19, *Cultellus*, pl. 3, species 11, 1874.
Siliqua patula var. *nuttallii* Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 22, p. 109, 1899; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 173, 1903; Dall, Bull. 112 U. S. Nat. Mus., p. 51, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 190, pl. 18, figs. 2*a*, 2*b*, 1924.
Siliqua nuttallii Conrad, Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 956, 1900; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 229, 232, 233, 239, 243, 245, 254, 1916; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, pp. 590 (+ *oregonia* Dall), 593, 596, 1913; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 281, pl. 26, figs. 2*a*, 2*b*, 1918; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922.
Siliqua (*patula* Dixon var.?) *oregonia* Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 957, 1900.

Shell large, altitude about four-ninths the length, beaks at about the anterior third, dorsal margins sloping away from them slightly, the anterior more than the posterior, anterior end strongly curving, posterior end somewhat truncated, both ends gaping, ventral margin nearly straight, sometimes bent in the middle, the posterior end of the shell sometimes slightly narrower; surface covered with a greenish epidermis, thin and yellow-green on smaller and more southerly specimens, heavy and brownish-green on old specimens or specimens that have lived in exposed or northerly localities, marked by concentric growth lines which show annual rings of different color or frequency, the northern specimens adding a narrower ring each year but living longer; hinge normal, the interior rib broad, low, sloping diagonally forward.

Dimensions: Length, 154 mm.; altitude, 67 mm.; convexity of the two valves, 28 mm.

Type specimens: Of *patula*, in the Swainson Collection (*fide* Oldroyd), London (?); of the other names by European authors, probably London or Paris; of *nuttallii* and *americana*, in the Academy of Natural Sciences, Philadelphia (?); of *oregonia* Dall, either in Philadelphia or in U. S. National Museum.

Type localities: Of *patula*, from Cook's River, Alaska; of *nuttallii*, inhabiting "salt marshes, somewhere towards Point Adams, in the estuary of the Columbia;" of *californica*, Bodega Bay, middle California; of *oregonia*, Empire formation, upper Miocene near Coos Bay, Oregon.

U. Miocene: Type locality of *oregonia* (Dall; Arnold and Hannibal; Howe).

Pliocene: Merced-Purisima formation of middle California (Arnold and Hannibal; Martin); Wildcat formation of northern California (Martin); Etchegoin of the San Joaquin basin, California (Martin); ? from a depth of 4450-68 feet in the General Petroleum Stiles well at McFarland, Kern Co., about a dozen specimens (H. R. G.).

Pleistocene: Rare in the upper San Pedro of San Pedro and of Spanish Bight, San Diego (Arnold); Pleistocene of Peard Bay, northern Alaska (Meek).

Living: Arctic Ocean to Monterey Bay, California.

This species, well known as the edible razor clam, has been thoroughly studied by the Fish Commission.[1] Thousands of specimens have been examined, their characters and habits analyzed, and the conclusion reached that the differences between the northern form (*patula*) and the southern form (*nuttallii*) are environmental, not genetic. Thus these two names must be considered absolutely synonymous. It is, nevertheless, worth while to note that the cold climate of the north causes the northerly individuals to grow more slowly, though they live longer and in the end attain a larger size, having a somewhat different, more weather-beaten appearance than their southern brothers. On the other hand, the form *alta*, usually considered a variety of *patula*, is shown to be a distinct and clearly recognizable species. It is distinguished by its greater proportionate altitude, increasing posteriorly, by its short anterior end, both of its ends being much blunter, and by the fact that the internal rib runs from the hinge nearly straight across the shell.

The young of *patula* are difficult to distinguish from *lucida*. However, the latter has a thinner shell, the internal rib is higher, sharper, and narrower, running straight across the shell, and the posterior end is blunter. The Pliocene specimens of *patula* look more like the Atlantic *costata* (Say), 1822, not (Schumacher), 1817, = *nahantensis* (Desmoulins), 1832, with which they may have had a common origin. It is even possible that the Pliocene specimens should be recognized as *nahantensis*, but the material is not well enough preserved to make certain identification possible.

Siliqua alta (Broderip and Sowerby)

Plate 21, Figure 1

Solen altus Broderip and Sowerby, Zool. Journ., Vol. 4, p. 362, 1829.

? *Solen medius* G. B. Sowerby, Zoology of Beechey's Voyage in the "Blossom," p. 153, pl. 46, fig. 2, 1839.

Siliqua media "Gray," Dall, Amer. Journ. Conch., Vol. 7, p. 141, pl. 14, fig. 11, 1871; Bull. 112 U. S. Nat. Mus., p. 51, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 189, in part (not the description which is taken from the Conch. Icon.), 1924.

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[1] McMillin, H. C.: "The Life History and Growth of the Razor Clam," pp. 1-52, ill., Olympia, Washington, 1924, in the 34th Ann. Rept., Supervisor of Fisheries of the State of Washington for 1923-24, 1925.

Weymouth, F. W., McMillin, H. C., and Holmes, H. B.: "Growth and Age at Maturity of the Pacific Razor Clam, Siliqua patula (Dixon)," Bull. Bureau Fisheries, U. S. Dept. Commerce, Vol. 41, pp. 201-236, ill., 1925.

"Cultellus costatus Say," Sowerby in Reeve, Conch. Icon., Vol. 19, *Cultellus*, pl. 3, fig. 8, species 20, 1874.
Not *"Cultellus medius* Gray," Sowerby in Reeve, Conch. Icon., Vol. 19, *Cultellus*, pl. 3, fig. 9, species 21, pl. 6, fig. 9*b*, 1874 (*fide* Dall).
Siliqua patula var. *alta* Broderip and Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 22, p. 109, 1899; Bull. 112 U. S. Nat. Mus., p. 51, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 190, pl. 47, figs. 1, 2, 1924.

Shell of medium or large size, altitude about half the length, beaks at about the anterior third, anterior dorsal margin beginning to round almost immediately and merging into the broadly rounding anterior end, posterior dorsal margin nearly straight for some distance and then slightly alate and bowing upward, posterior extremity very bluntly rounded, ventral margin nearly straight, the posterior end of the shell noticeably broader than the anterior; hinge teeth strong, interior rib broad, low, crossing the shell vertically.

Dimensions: Length, 125 mm.; altitude at hinge, 54 mm., maximum at posterior end, 62 mm.; convexity of two valves, 27 mm.

Type specimens: In the British Museum (?).

Type localities: Of *alta*, Arctic Ocean; of *media*, Alaska (?).

Living: Arctic Ocean, south to Cook's Inlet, Alaska, and to the Okhotsk Sea.

This species is similar to *nahantensis* (Desmoulins) from the Atlantic in that it has the vertical internal rib of the latter and about the same shape; but the adult is larger, relatively shorter, with blunter ends, and the posterior end broadens in a characteristic way, whereas that of *nahantensis* tapers off. Dall (1899, p. 108) gives the synonymy of *nahantensis* (+ *costata* Say not Schumacher). *S. alta* is similarly distinguished from *S. patula;* and in addition, *S. patula* has a diagonal internal rib. The form figured by Dall as *media* and erroneously attributed to Gray, and Dall's description, together with a specimen in the Oldroyd Collection at Stanford University which was labeled by Dall in Washington, agree exactly with the young of *S. alta*. The *"Cultellus medius"* of Sowerby in Reeve is, according to Dall, the Atlantic *S. squama* Blainville, 1824.

Siliqua lucida (Conrad)

Plate 21, Figure 6

Solecurtus lucidus Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, p. 231, pl. 17, fig. 8, 1837.
Siliqua lucida Conrad, Dall, Amer. Journ. Conch., Vol. 7, p. 141, 1871; Proc. U. S. Nat. Mus., Vol. 22, p. 109, 1899; Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 957, 1900; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 172, 1903; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, pl. 44, fig. 3, 1915; Nomland, Vol. 9, p. 203, 1916; Martin, pp. 239, 254, 1916; Moody, Vol. 10, p. 45, 1916; Nomland, pp. 212, 221, 301, 302, 1917; Dall, Bull. 112, U. S. Nat. Mus., p. 50, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 189, pl. 52, fig. 2, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Shell small, thin, elongate, beaks about a quarter of the distance from the anterior end, anterior end short and rounded, posterior dorsal margin nearly straight, posterior extremity blunt, ventral margin moderately convex; sculpture of fine growth lines and annual rings; hinge normal, internal rib sharp and narrow, undercut on the posterior side near the hinge, crossing the shell vertically; pallial sinus moderately deep, rounded.

Dimensions: Length, 40 mm.; altitude, 11 mm.; convexity of two valves, 6 mm.

Type specimen: In the Academy of Natural Sciences, Philadelphia (?).

Type locality: Recent, near Santa Barbara.

U. Miocene: San Pablo-Santa Margarita of middle California (Clark; Nomland, 1917).
Pliocene: Lower Etchegoin and Jacalitos of the San Joaquin basin, common (Nomland, 1916, 1917); common in the basal marine Pliocene of the well cores of the Fruitvale district, near Bakersfield (H. R. G.); middle or upper Etchegoin of a depth of 3000-18 feet in the General Petroleum Co., Stiles well at McFarland, Kern Co., north of Bakersfield, fifty specimens (H. R. G.); middle Wildcat formation of northern California (Martin); upper Pliocene of Fourth and Broadway, Los Angeles (Moody).
Pleistocene: Lower and upper San Pedro series of San Pedro, Los Angeles Co., (Arnold); 26th Street, and Spanish Bight, San Diego (Arnold); San Quintin Bay, Lower California (Jordan).
Living: Monterey, California, to Todos Santos Bay, Lower California (Dall, 1921).

This species is clearly distinct from the others. It is smaller and so thin that the rib shows through plainly, even on fossil specimens. It has a more southerly modern distribution, and occurs farther south and in the warmer water horizons of the Tertiary. Young specimens of *patula* might be confused; but *lucida* can be distinguished by its narrower and higher internal rib crossing the shell at right angles, by its shorter anterior extremity, by its blunter posterior extremity, and by its more arcuate ventral margin.

Superfamily MACTRACEA

Family MACTRIDAE

Shell rounded-trigonal or elongate, equivalved, with or without a posterior gape; umbones inclined forward; hinge normally with a bifid Λ-shaped cardinal in the left valve embraced by a similar tooth in the opposite valve, sometimes with accessory tooth-like processes, and generally with well-developed lateral teeth; chondrophore posterior to the cardinals, rather prominent, excavated; ligament small, external or internal; pallial sinus generally short and rounded.

The *Mactridæ* form a large group of smooth or concentrically sculptured, rounded-trigonal or elongate-ovate shells which are readily recognized by their prominent chondrophores and bifid Λ-shaped cardinal teeth.[1] The family originated in the Mesozoic, a number of species having been recorded from the Cretaceous.

The genera and subgenera of the *Mactridæ* have been differentiated by the characters of the hinge. The position of the ligament has been the fundamental character in the subdivision of *Mactra, sensu lato*. Gray, in his Synoptical Catalogue of 1837[2] and in a later important contribution,[3] laid the foundation of a classification of the *Mactridæ* which has been the basis of all subsequent work. Dall's discussions[4] of the Mactras have been based upon Gray's pioneer work, and, as a whole, have added to our knowledge of the group; but the contributions of his writings have been offset by the creation of some illogical subdivisions. More recently Packard[5] published a well-illustrated paper on the Mesozoic and Cenozoic *Mactrinæ* of the Pacific coast of North America in which much scattered information on Pacific coast species has been collected. In 1917 Lamy[6] published a revision of the living Mactras in the Paris Museum, figuring many hinges and contributing information on the genera and species.

Genus MACTRA Linnæus, 1767

Mactra Linnæus, Syst. Nat., Ed. 12, p. 1125, 1767, list includes *M. stultorum;* Gray, Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 371, 1837; Proc. Zool. Soc. London, Pt. 15, p. 185, 1847; Cossmann, Ann. Soc. Roy. Malac. Belg., Vol. 21, p. 60, 1886; Dall, Nautilus, Vol. 8, pp. 25, 26, 1894; Proc. Malac. Soc. London, Vol. 1, pp. 203-208, 211, 1895; Trans. Wagner Inst. Sci., Vol. 3, p. 874, 1898; Lamy, Journ. Conchyl., Ser. 4, Vol. 17, p. 176, 1917.
Trigonella Da Costa, Hist. Nat. Test. Brit., p. 196, 1778.
Crassatella Lamarck, Mém. Soc. Hist. Nat., Paris, Ser. 1, Vol. 1, p. 85, 1799.

Type (by subsequent designation, Gray, 1847), *Mactra stultorum* (Linnæus), Syst. Nat., Ed. 12, p. 1126, 1767; = *Cardium stultorum* Linnæus, Ed. 10, p. 681, 1758; figured by Reeve, Conch. Icon., Vol. 8, *Mactra*, pl. 4, fig. 15, 1854; see Lamy, *op. cit.*, pp. 180-188, figs. on p. 177, 1917; European seas.

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[1] The cardinal tooth in the right valve appears to be the result of the coalescence at the top of two diverging teeth.

[2] Loudon's Magazine of Natural History, New Series, Vol. 1, no. 7, pp. 370-377, July, 1837.

[3] Ann. Mag. Nat. Hist., Ser. 2, Vol. 11, pp. 41-44, January, 1853.

[4] Nautilus, Vol. 8, pp. 26-28, 1894; Proc. Malac. Soc. London, Vol. 1, pp. 203-213, 1895; Trans. Wagner Inst. Sci., Vol. 3, pp. 862-916, 1895.

[5] Univ. Calif. Publ. Geol., Vol. 9, pp. 261-360, pls. 12-35, text figs., May 1, 1916.

[6] Journ. de Conchyliologie, Ser. 4, Vol. 17, pp. 173-275, 292-411, with many figures of hinges, including those of type species, 1917.

Shell ovate-trigonal, generally almost equilateral; hinge with laterals well developed, a small spur sometimes projecting over the chondrophore from the cardinal margin.

The differentiation of typical *Mactra*, *Spisula*, and *Mulinia* has been based largely on the position of the ligament. In *Mactra*, *s. s.*, as typified by *M. stultorum*, the ligament, though very small, is clearly visible from the exterior. An umbonal view of a pair of matched valves discloses a small crack between and slightly posterior to the umbones. In fresh or living specimens the ligament occupies this space. A hinge view shows a very small, narrow shelly ridge separating the shelf-like ligamental pit from the chondrophoric cavity. The presence of this shelly ridge serves to distinguish *Mactra*, *s. s.*, from *Spisula*. The hinge of *Mactra solida* (Linnæus), the type of *Spisula*, shows that the ligament, while still partly external, is not separated from the chondrophoric pit, the shelly process which separated the two in *Mactra stultorum* being absent. When the partition is absent in a specimen it is necessary to ascertain if it has been broken away by accident. *Mulinia* differs from both *Mactra*, *s. s.*, and *Spisula* by having an entirely internal ligament. An umbonal view of two perfect, matched valves of *Mulinia* shows no crack or chink between the margins of the valves in the umbonal area, the ligament having descended into the resilial pit. Thus a study of the hinge of good specimens of *Mactra*, *sensu lato*, will permit the placing of the species in the proper subgenera.

This character, the position of the ligament, although it may be of systematic value, does not appear to the writers to be entitled to more than subgeneric distinction; and accordingly *Spisula* and *Mulinia* have been treated here as subgenera of *Mactra*. Such an arrangement will often relieve the paleontologist of the necessity of guessing whether poorly preserved specimens belong to *Spisula* or to *Mactra*, since the name *Mactra* can be used for both, and the subgenus left undecided.

Subgenus **MACTRA**, s. s.

Hinge with a small external ligament in a slight depression separated from the chondrophore by a small shelly ridge.

Lamy has figured the hinge of *Mactra corallina* (Linnæus), of which species he considers *stultorum* a variety (*op. cit.*, figures on page 177). These figures are accurate and depict well the hinge characters of typical *Mactra*.

Section Mactra, s. s.

Shell ovate, moderately convex; lateral teeth long.

Mactra (Mactra) orthomorpha, new species

Plate 23, Figures 2*a*, 2*b*, 2*c*, 6, 7

Shell ovate-subtrigonal, moderately ventricose, of moderate thickness; umbones rather full, coming to a blunt point at the dorsal margins of the valves; surface of valves marked with fine, low, irregular growth lines and a low angulation running from the umbo to the posterior ventral margin; hinge normal, chondrophore prominent, wide, overhung by a spur, lateral laminæ rather long, well-developed, in the right valve a second set attached to the dorsal margin of the valve. Length, about 39 mm.; height, about 32 mm.; convexity of one valve, about 12 mm.

Type specimen: S. D. S. N. H. No. 193.

Type locality: Federal Exploration Company's well, Kinsella No. 1, depth 2794 feet, Sec. 15, T. 22, R. 24, near Tipton, Tulare County, California; upper middle Etchegoin formation, Pliocene.

This new species shows such a striking similarity to specimens of *Mactra stultorum* (Linnæus) from the Mediterranean Sea that it is difficult to believe that they are not closely related. In size, general shape, and in character of the hinge the two are practically identical. The California species has a somewhat heavier shell, stronger lateral teeth, a larger chondrophore, and more prominent concentric growth lines on the exterior of the shell. In the right valve of both species the anterior branch of the ∧-shaped cardinal is partly coalescent above with the dorsal margin of the valve. Specimens labeled *Mactra sachalinensis* Schrenck[1] in the Oldroyd Collection at Stanford University (from Oshima, Japan), differ significantly only in size, the Japanese shells being very much larger (length, 89 mm.; height, 70 mm.).

Mactra orthomorpha is entirely different from *Mactra californica* Conrad, which is a relatively much longer and less ventricose shell, with shorter lateral teeth. Conrad's species is also thinner shelled. "*Mulinia*" *pabloensis* Packard,[2] of the upper Miocene of Contra Costa County, may be related to this new species. Packard's species is larger, has broader umbones and heavier laterals, which have transverse striations. It is not a *Mulinia*.

Section Mactrotoma Dall, 1894

Mactrotoma Dall, Nautilus, Vol. 8, p. 26, 1894; Trans. Wagner Inst. Sci., Vol. 3, p. 876, 1898.

Type (by original designation, Dall, 1894), *Mactra fragilis* Gmelin; figured by Reeve, Conch. Icon., *Mactra*, sp. 47, pl. 11, fig. 47, 1854; and by Dall, Trans. Wagner Inst. Sci., Vol. 3, pl. 27, figs. 1, 4, 8, 18, 1898; also by Lamy, Journ. Conchyl., Ser. 4, Vol. 17, figs. on p. 179, 1917; North Atlantic, Recent.

Shell elongate, sometimes of low convexity; laterals short.

Mactra (Mactra) californica Conrad

Mactra californica Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 240, pl. 18, fig. 12, 1837; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 876, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 174, pl. 19, fig. 2, 1903; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 151, 152, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 251, 1929; not *Mactra californica* Deshayes in Reeve, Conch. Icon., Vol. 8, *Mactra*, sp. 114, May, 1854; nor of Deshayes, Proc. Zool. Soc. London, Pt. 22, p. 68, February 10, 1855, for date, see Tomlin, Journ. Conch., Vol. 17, p. 134, 1924; not "*Mactra californica* Conrad," Reagan, Trans. Kansas Acad. Sci., Vol. 22, pl. 4, fig. 41, 1909.

Mactra augusta Deshayes in Reeve, Conch. Icon., Vol. 8, *Mactra*, sp. 93, pl. 18, fig. 93, May, 1854; Deshayes, Proc. Zool. Soc. London, Pt. 22, pl. 67, Feb. 10, 1855.

Mactra (*Mactrotoma*) *californica* Conrad, Dall, Nautilus, Vol. 8, p. 40, 1894; Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 280, pl. 16, figs. 4*a-c*, 1916; Lamy, Journ. Conchyl., Ser. 4, Vol. 17, pp. 251, 252, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 51, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 192, pl. 20, figs. 4, 5, 6, 1924; Strong, Nautilus, Vol. 38, p. 99, 1925.

"*Spisula* (*Symmorphomactra*) *planulata* Conrad," Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, pl. 17, figs. 4-6 only (reproductions of Packard's figures), 1924.

"*Mactra nasuta* Gould," of some authors, not of Gould.

Type locality: Santa Barbara, California; Recent.

Pleistocene: Upper San Pedro series of San Pedro, "one specimen" (Arnold, 1903); Pleistocene of Santa Monica, one specimen (T. S. Oldroyd Collection); foot of Twenty-sixth Street, San Diego, common (Arnold; F. Stephens); upper Pleistocene of San Quintin Bay, of San Ignacio Lagoon and of Scammons Lagoon, Lower California, Mexico (Jordan, 1924, 1926).

Recent: Neah Bay, Washington, to Panama.

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[1] Bull. Acad. Imp. Sci. St. Petersburg, Vol. 4, p. 412, October, 1861; Mollusken des Amurlandes und des Nordjapanischen Meeres, p. 575, pl. 23, figs. 3-7.

[2] Univ. Calif. Publ. Geol., Vol. 9, p. 309, pl. 34, figs. 5, 6, 1916.

This is the common small *Mactra* of southern California. It is rather flat, elongate, and the laterals are short and close to the cardinals and chondrophore. It is the type of Dall's section *Micromactra*.[1]

Mactra (Mactra) dolabriformis (Conrad)

Spisula dolabriformis Conrad, Amer. Journ. Conch., Vol. 3, p. 193, 1867, as "*Spissula*," *err. pro Spisula*, corrected in appendix, p. 44.

Mactra dolabriformis Conrad, Dall, Natuilus, Vol. 7, p. 138, pl. 5, fig. 1, 1894; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Mactra (*Mactrotoma*) *dolabriformis* Conrad, Dall, Nautilus, Vol. 8, p. 40, 1894; Trans. Wagner Inst. Sci., Vol. 3, p. 876, 1898; Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 279, 1916; Dall, U. S. Nat. Mus., Bull. 112, p. 51, 1921: I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 191, 1924; Strong, Nautilus, Vol. 38, p. 100, 1925.

Mactra (*Simomactra*) *dolabriformis* Conrad, Lamy, Journ. Conchyl., Ser. 4, Vol. 17, p. 263, 1917.

Type locality: "Panama," according to Conrad; Recent.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: West coast of Lower California and the Gulf of California; Panama range denied by Dall, who reports the species from California; California range questioned by the present writers.

Mactra dolabriformis (Conrad), according to Strong,[2] "is a rare species of which a few specimens have been dredged in southern California waters. The shell is much compressed, resembling *Spisula falcata* Gld., but with more central beaks, more elongate shape, and larger size, the adult three and a half to four inches in length." Mr. Strong is now of the opinion that the California shells may not belong to this species. *M. dolabriformis* is the type of Dall's section *Simomactra*.[3]

Specimens of *Mactra dolabriformis* Conrad are similar in shape to Gould's type figures of *M. falcata*. Even the hinges are very similar except that *dolabriformis* has a strong shelly ridge between the ligament and the chondrophore, which places it in *Mactra, s. s.*

Subgenus **SPISULA** Gray, 1837

Spisula Gray, Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 372, July, 1837; Proc. Zool. Soc. London for 1847, p. 185, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 895, 896, 1898; Lamy, Journ. Conchyl., Ser. 4, Vol. 17, pp. 291, 292, 1917.

Type (by subsequent designation, Gray, 1847), *Mactra solida* (Linnæus), Syst. Nat., Ed. 10, p. 681, as *Cardium;* hinge figured by Lamy, *op. cit.*, figs. on p. 292, 1917.

Hinge with a small external ligament in a depression not separated from the chondrophore by a shelly ridge.

The small size of the Mactroid ligament and the difficulty of observing the small shelly ridge, particularly in fossil specimens, sometimes make the determination of the subgeneric group to which a particular specimen belongs a difficult matter. In *Spisula* there is no sign of a shelly ridge between the chondrophore and the ligamental cavity.

Section Spisula, s. s.

Shell small or of moderate size, subtrigonal; beaks small, central, only slightly inclined forward; hinge with large laterals; rather small cardinals, and a moderate-sized chondrophore.

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[1] Dall, Nautilus, Vol. 8, p. 40, 1894, only species *Mactra* (*Mactrotoma*) *californica* Conrad.

[2] *Op. cit.*, p. 100, 1925.

[3] Nautilus, Vol. 8, p. 40, 1894, only species *Mactra* (*Mactrotoma*) *dolabriformis* Conrad.

Section MACTROMERIS Conrad, 1868

Mactromeris Conrad, "Cat. Mactridæ," Amer. Journ. Conch., Vol. 3, Appendix, p. 45, 1868; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 878, 1898; Lamy, Journ. Conchyl., Ser. 4, Vol. 17, p. 293, 1917.

Symmorphomactra Dall, Nautilus, Vol. 8, p. 41, 1894, type (by monotypy) *Mactra falcata* Gould.

Type (by subsequent designation, Dall, 1898), *M. polynyma* Stimpson, Checklist Shells N. A., Smithsonian Misc. Coll., Vol. 2, Art. 6, No. 3, p. 3, 1860 (+ *M. ovalis* Gould, 1840, not J. Sowerby, 1817); figured by Lamy, *op. cit.*, p. 293, 1917.

Shell of moderate or large size, ovate, subtrigonal; beaks more anterior than in *Spisula, s. s.*; hinge with relatively small, short laterals, an ample chondrophore, and cardinal teeth often small but well formed.

The Pacific coast Mactras that have been placed in *Hemimactra* Swainson[1] do not belong there, unless the group is much enlarged in meaning to include species very far from the typical. Swainson characterized *Hemimactra* as being of the "general form of *Mactra;* but the cardinal teeth entirely wanting." Examination of specimens of the type species, *Mactra gigantea* Lamarck, shows that the lack of well-developed cardinals is the result of the very large chondrophore, which has crowded the cardinals and caused them to approach obsolescence. They exist, however, as vestiges, in the left valve as two low, closely-appressed ridges, and in the right valve as a poorly developed, Λ-shaped tooth with the apex at the dorsal margin of the valve. In the type species, the umbones terminate at the actual dorsal margins of the valves, just above the apices of these minute cardinal teeth. *S. catilliformis* and *S. hemphilli* have normal cardinal teeth, and only by enlarging the scope of *Hemimactra* beyond its differentiable characters could these California species be placed therein. Furthermore, these species are clearly much more closely related to *Mactra polynyma.*

Mactra (Spisula) polynyma Stimpson

Mactra similis Gray in Wood, Index Testac., Supplement, pl. 1, fig. 5, 1828; Beechey's Voy., Appendix, p. 154, pl. 44 fig. 8, 1828; not Say, 1822, *fide* Gould, 1841.

Mactra grandis Deshayes, Ency. Méth., Vers, Vol. 2, p. 395, 1832; not Gmelin, 1788, *fide* Gould, 1841.

Mactra ovalis Gould, Silliman's Amer. Journ. Sci., N. S., Vol. 38, p. 196, 1840; Invert. Massachusetts, Ed. 1, p. 53, fig. 32, 1841; not Sowerby, 1817; Binney Edition, p. 75, fig. 32, 1870, figure reproduced by Dall, Bull. 37, U. S. Nat. Mus., pl. 70, 1889; not of Sowerby, 1817.

Mactra ponderosa Philippi, Abbild. Beschreib. Conchyl., Bd. 1, Heft 7, p. 1, pl. 1, fig. 1, October, 1844; not Conrad, 1830.

Mactra polynyma Stimpson, Checklist East Coast Shells, Smithsonian Misc. Coll., Vol. 2, Art. 6, No. 3, p. 3, 1860, new name for *M. ovalis* Gould.

M. (*Spisula*) *grayana* Schrenck, 1867, *fide* Dall, 1894.

Spisula (*Mactromeris*) *polynyma* Stimpson, Lamy, Journ. Conchyl., Ser. 4, Vol. 17, pp. 319-320, 1917.

Distribution: Hudson's Bay south to Massachusetts and (?) Long Island, New York.

This species is figured by Gould, Binney, Dall, and others, and need not be described here. It is a rather large shell. Although somewhat variable in shape, it is on the average more elongate than its Pacific coast variety. The figure given by Philippi, however (as *M. ponderosa*), shows a high-beaked form, and a study of more Atlantic and Pacific coast specimens may show the necessity of synonymizing the Pacific variety.

Lamy has given a list of references to *polynyma* and its synonyms.

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[1] Treat. Malac., p. 369, 1840, only species *H. gigantea* (Lamarck) and *H. grandis* Swainson; type designated by Gray, Proc. Zool. Soc. London for 1847, p. 185, 1847, *M. gigantea* Lamarck, Hist Anim. s. Vert., Vol. 5, p. 472, 1818. This is *Mactra solidissima* Chemnitz, Neues Syst. Conchyl. Cab., Vol. 10, p. 350, pl. 170, fig. 1656, 1788; also figured by Reeve, Conch. Icon., Vol. 8, *Mactra*, pl. 11, fig. 8, 1854. This latter figure is an excellent illustration, showing the hinge as well as the exterior of a valve. Lamy also figures the type, *op. cit.*, figure on p. 292 (as *Hemimactra solidissima* (Chemnitz)).

Mactra (Spisula) polynyma Stimpson variety **voyi** (Gabb)

Callista voyi Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 24, pl. 5, fig. 41, 1866.
"*Mactra ovalis* Gould," Middendorff, Reise in dem Aussersten Norden und Osten Sibiriens während 1843 und 1844, Bd. 2, Thl. 1, p. 363, 1851; not of Gould, Inv. Mass., Ed. 1, p. 53, 1841.
Mactra polynyma variety *alaskana* Dall, Nautilus, Vol. 7, p. 128, April, 1894; Vol. 8, p. 40, August, 1894.
Spisula alaskensis Dall, U. S. Geol. Surv., Prof. Paper 59, p. 131, 1909.
Mactra (Spisula) alaskana Dall, Baker, Nautilus, Vol. 24, p. 46, 1910.
Spisula alaskana Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913; Dall, Journ. Wash. Acad. Sci., Vol. 19, p. 2, 1919.
Spisula voyi (Gabb), Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 254, 1916; Packard, Vol. 9, p. 283, pl. 13, fig. 4, pl. 14, figs. 1, 2, pl. 15, figs. 1*a*, 1*b*, 2, 1916; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922.
Hemimactra (polynyma Stimpson, var.) *alaskana* Dall, U. S. Nat. Mus., Bull. 112, p. 51, 1921.
Spisula (Hemimactra) voyi Gabb, I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 59, pl. 38, figs. 1, 2, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 193, pl. 23, figs. 1, 2, 1924.
Not "*Spisula (Hemimactra) alaskana* Dall," Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 59, pl. 4, fig. 4, 1924.

Type locality: Near Humboldt Bay, below Bear River, Humboldt County; Pliocene.

Pliocene: Various localities near Nome, Alaska (Dall, 1913); St. George Island, Pribilof group (Dall, 1919); near Humboldt Bay, at the type locality (Gabb); middle Wildcat formation of Humboldt County; Merced of Sargent oil field (Martin); Merced formation of Wilson's Ranch, Sonoma County (Dickerson).
Recent: Arctic Ocean at Cape Lisburne, south to Bering Sea and the Aleutians and eastward to Puget Sound (Dall, 1921); north Japan, the Kurile Islands and the Okhotsk Sea (Schrenck).

The variety *voyi* (Gabb) appears on the average to be less elongate than the typical form of the species, although Gabb's type figure appears to represent an elongate valve of the Pacific form, and Philippi's figure depicts a high form of the eastern shell. The slight differences between the hinges of Atlantic and Pacific specimens seem to be individual variations, but we have had insufficient Atlantic specimens to be certain. It appears quite certain that variety *alaskana* Dall and *voyi* (Gabb) are identical, and that the Pacific Pliocene to Recent shell is at most a variety of *polynyma* Stimpson.

Mactra (Spisula) brevirostrata (Packard)

Spisula brevirostrata Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 296, pl. 28, figs. 1*a*, 1*b*, 2, 1916.

Type specimen: In the University of California Collection.

Type locality: One mile north of Scotia, Humboldt County; Pliocene.

Pliocene: Wildcat formation, Pliocene of Humboldt County (Packard).

This form appears to be intermediate in characters between *albaria* and *voyi*, forms which occur abundantly in the Wildcat beds and seem to intergrade there. It may be a synonym of either.

Mactra (Spisula) albaria Conrad

Plate 23, Figures 3*a*, 3*b*

Mactra albaria Conrad, Amer. Journ. Sci., Ser. 2, Vol. 5, p. 432, fig. 4, 1848, reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 150, fig. 4, 1909; Amer. Journ. Conch., Vol. 1, p. 152, 1865; Meek, Checklist Miocene Foss. N. A., p. 11, 1864; Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896; ? Arnold, U. S. Geol. Surv., Bull. 396, p. 30, pl. 19, fig. 4, Jan. 15, 1910; ? Bull. 398, pl. 41, same figure, 1910; J. P. Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 167, 172, 1912.
Mactra diegoana Conrad, U. S. House of Representatives, Document No. 129, p. 14, 1855; U. S. Pacific R. R. Repts., Vol. 5, p. 325, pl. 5, fig. 45, 1855; reprinted by Dall, 1909.
"*Standella planulata* Conrad, sp.", Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 91, 1868-9; not of Conrad, 1837.
Spisula (Hemimactra) albaria Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 130, pl. 10, fig. 1, 1909.
Spisula (Hemimactra) precursor Dall, U. S. Geol. Surv., Prof. Paper 59, p. 131, pl. 14, fig. 10, 1909.

"*Mactra gibbsana* Meek," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 187, pl. 2, figs. 19*a*, 19*b*, 1909, *fide* Dall, 1922.

? "*Tivela crassatelloides* Conrad," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 208, pl. 4, figs. 37*a-c*, 1909; not of Conrad.

Spisula albaria Conrad, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 576, 583, 588, 590, 594, 596 (cf.), 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, pl. 60, fig. 8, 1915; Nomland, Vol. 9, p. 203, 1916; Martin, Vol. 9, p. 254, 1916; Weaver, Proc. Calif. Acad. Sci., Ser. 4, Vol. 6, p. 37, 1916; Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 290, pl. 24, fig. 1, pl. 25, figs. 3-8, 1916; Nomland, Vol. 10, p. 220, 1917; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922; Clark, Univ. Calif. Publ. Geol., Vol. 15, p. 99, 1924.

Spisula albaria Con. var. *coosensis* Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 99, pl. 9, figs. 6, 7, 1922.

Mactra (*Spisula*) *arnoldi* Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 310, 1922.

Type locality: On the Columbia River, near Astoria, Oregon; Miocene.

Oligocene: Sooke formation of the southern coast of Vancouver Island; Newport, Oregon; Astoria, Oregon; Seattle horizon of Astoria series (Arnold and Hannibal; etc.).

Miocene: Near Astoria, Oregon (Conrad; Clark, 1924); Nushagak, Alaska (Dall, 1896); Monterey formation, Clallam Bay district, Washington, and at Astoria, Oregon (Arnold and Hannibal); Empire formation of Oregon (Dall, 1909, as "*S. precursor;*" Arnold and Hannibal); San Pablo and Santa Margarita formations of middle California (Clark, 1915; etc.).

Pliocene: Middle Wildcat formation, Humboldt County (Martin); Merced and Purisima formations south of San Francisco; Sonoma County (Dickerson); Etchegoin of Sargent oil field, Pajaro Valley (Martin; Nomland; etc.); Etchegoin of Coalinga district (Arnold, 1910; Nomland), including the Jacalitos formation (Clark, 1915); etc.

This species has been figured and discussed by Packard, who recognizes a certain amount of variation, but gives the range of the species as upper Miocene (San Pablo) to Pliocene ("Merced group"). The older records may have to be referred to varieties of the typical form. The original figure of Conrad is inadequate for specific differentiation; but Howe collected specimens at the type locality, and on the basis of small differences in the cardinal teeth of topotypes and of the *albaria* of Dall, Packard, and others, described a new variety. This variety we have tentatively placed in synonymy. Much more critical work will have to be done on this group before *albaria* and its possible varieties are well known.

Mactra (Spisula) falcata Gould

Mactra falcata Gould, Proc. Bost. Soc. Nat. Hist., Vol. 3, p. 216, 1850; U. S. Exploring Exped. (Wilkes), Vol. 12, p. 393, 1852, Mollusca Atlas, pl. 34, figs. 506, 506*a*, 506*b*, 1856, description reprinted in Gould's Otia Conchologica, p. 76, Boston, 1862.

Standella falcata Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864, reprinted in Smithsonian Misc. Coll. No. 252, p. 126 (bottom pagination), 1872; ? Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 92, 1868-9; ? Cooper, 7th Ann. Rept. State Mineralogist, p. 266, in part only, 1888; Keep, West Coast Shells, p. 198, 1888; 1892; West American Shells, p. 97, in part, 1904.

Spisula falcata Gould, Keep, West American Shells, Ed. 1, p. 97, in part, 1904; Ed. 2, p. 107, in part, 1911; ? Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, 1915, questionably identified; Martin, Vol. 9, p. 254, 1916; Oldroyd, Univ. Wash., Publ. Puget Sound Biol. Sta., Vol. 4, p. 60, pl. 17, figs. 1-3 (reproductions of Gould's original figures), 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 195, pl. 20, figs. 1-3 (same figures), 1924.

"*Spisula planulata* Conrad," Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 293, pl. 16, figs. 3*a*, 3*b*, 3*c*, 1916.

Spisula (*Hemimactra*) *falcata* Gould, Dall, Bull. 112, U. S. Nat. Mus., p. 52, in part, 1921.

"*Spisula* (*Hemimactra*) *alaskana* Dall," Oldroyd, Univ. Wash., Publ. Puget Sound Biol. Sta., Vol. 4, p. 59, pl. 4, fig. 4, 1924.

Type locality: Puget Sound, Washington; Recent.

? ? *Miocene:* Reported from various localities in the upper Miocene,—Kirker's Pass, Contra Costa Co. (Gabb), San Pablo, questionably identified (Clark), etc.—; but these occurrences must be considered extremely doubtful until the identifications are confirmed by an examination of specimens.

? *Pliocene:* Wildcat beds of northern California, Humboldt Co. (Cooper); Merced of Seven Mile Beach, middle California (Cooper); Merced of the Sargent oil field (Martin);—occurrences more probable than those of the Miocene but should be verified.

Recent: Queen Charlotte Islands and Puget Sound, possibly as far south as Cape Mendocino, but more southerly reports probably erroneous.

Mactra falcata is very similar to *M. polynyma* variety *voyi*, to *M. planulata*, and to *M. dolabriformis*. It has been confused with *voyi* and *planulata* by Arnold, Dall, Packard, Oldroyd, and others, and all the reports of occurrences in the literature must be verified. *M. dolabriformis* is very much like *falcata* in shape and hinge characters except that it has a well-defined ridge on the dorsal rim of the chondrophore separating the resilium from the ligament, and is therefore classed tentatively in the subgenus *Mactra, s. s.* There are also minor differences. The differences separating *falcata* from *voyi* and *planulata*, on the other hand, are all very slight, so slight that there can be little question about their relationship. They might even be considered varieties of a single species, or at least very young species that have just recently split off from a common stock. The fossil specimens may converge so that it will be found impossible to trace the slight differences back into the fossil record. It is absurd to separate *falcata* from *polynyma*, as Dall did in naming the section *Symmorphomactra*.

Mactra falcata is well figured by Gould in the Mollusca Atlas to the U. S. Exploring Expedition Reports, and Gould's figures are twice reproduced by Oldroyd. It is smaller than *voyi* but is about the same shape as the young of that species, which are more produced anteriorly than the adults. The hinge is distinguished from that of *voyi* by the presence of accessory lamellæ prolonging the anterior lateral teeth in the direction of the beaks, the one in the right valve nearly joining onto the anterior arm of the cardinal, the one in the left passing behind the cardinal. Like *voyi*, *falcata* is characteristically northern in its distribution.

Mactra planulata, on the other hand, is characteristically southern in its distribution. It is usually a little more equilateral in shape, has a thicker shell, which is marked internally by irregularities radiating from under the beaks; and the hinge can be distinguished by the separating of the shorter anterior laterals from the accessory lamellæ, the anterior arm of the right cardinal with the lamella attached being more oblique and distant from the laterals.

Mactra (Spisula) planulata Conrad

Mactra planulata Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, p. 240, 1837.

? Standella planulata Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864, reprinted in Smithsonian Misc. Coll., No. 252, p. 126 (bottom pagination), 1872; not of Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 91, 1868-9, fossil records = *albaria* Conrad (*fide* Packard); nor of Cooper, Stearns, etc. (*fide* Packard); not of Keep, West Coast Shells, p. 188, fig. 161, 1888, 1892.

Spisula (*Mactromeris*) *planulata* Conrad, Amer. Journ. Conch., Vol. 3, Appendix, p. 45, 1868.

Mactra planulata "var. *falcata* Gould," Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 187, 1892.

Spisula (*Hemimactra*) *planulata* Conrad, Dall, Nautilus, Vol. 8, p. 40, 1894.

"*Spisula* (*Symmorphomactra*) *falcata* Gould," Dall, Nautilus, Vol. 8, p. 41, in part, 1894; Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 297, pl. 26, figs. 1*a*, 1*b*, 1*c*, 1916; Strong, Nautilus, Vol. 38, p. 102, 1925.

"*Mactra* (*Spisula*) *falcata* Gould," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 176, pl. 19, fig. 1, 1903.

Spisula (*Symmorphomactra*) *planulata* Conrad, Dall, Bull. 112, U. S. Nat. Mus., p. 52, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 195, 1924.

Not "*Spisula* (*Symmorphomactra*) *planulata* Conrad," Oldroyd, Univ. Wash., Publ. Puget Sound Biol. Sta., Vol. 4, p. 60 (= *falcata*), pl. 17, figs. 4-6 (which are reproductions of Packard's illustrations of *Mactra californica*), 1924.

Spisula planulata Conrad, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type locality: Near Santa Barbara; Recent.

?? Miocene: Possibly some of the reports of *falcata*, etc., by Gabb, Cooper, etc.

? Pliocene: Possibly some of the reports of *falcata* by Cooper, Martin, etc.

Pleistocene: Lower San Pedro series at San Pedro and Deadman Island, also Los Cerritos (= Signal Hill), Los Angeles Co. (Arnold); upper San Pedro series of the San Pedro region (Arnold); upper San Pedro series of Spanish Bight, San Diego (Arnold); upper Pleistocene of San Quintin Bay, Lower California (Jordan).

Recent: Monterey, California, to Cape San Lucas, Lower California (Dall, 1921).

For a comparison with this species, see the notes on *M. falcata*.

Mactra (Spisula) hemphilli Dall

Mactra hemphilli Dall, Nautilus, Vol. 7, p. 137, pl. 5, fig. 2, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 175, pl. 19, fig. 3, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 526, 1907.

Spisula (*Hemimactra*) *hemphilli* Dall, Nautilus, Vol. 8, p. 40, 1894; U. S. Nat. Mus., Bull. 112, p. 52, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 194, pls. 46, 50, 1924; Strong, Nautilus, Vol. 38, p. 101, 1925.

Spisula hemphilli Dall, Keep, West Amer. Shells, p. 106, 1911; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 254, 1916; Packard, Vol. 9, p. 287, pls. 21, 22, 1916; Nomland, Vol. 10, p. 220, 1917; not of Reagan, 1909, *fide* Dall, 1922.

Spisula cameronis Dall, West American Scientist, Vol. 19, No. 3, p. 22, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 26, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Type specimens: In the U. S. National Museum.

Type localities: Of *hemphilli*, San Diego, California; Recent; of *cameronis*, San Quintin Bay, Lower California, Mexico; Pleistocene.

Pliocene: Chione elsmerensis zone, lower part of the Etchegoin formation, lower Pliocene of the Coalinga region (Nomland); Purisima and Merced formations south of San Francisco (Martin); lower Fernando of Elsmere Canyon, Los Angeles County (questionably identified, Arnold, 1907).

Pleistocene: Rare in upper San Pedro series at San Pedro; common at the foot of Twenty-sixth Street, San Diego (Arnold, 1903); Newport, Los Angeles County (Packard, 1916); upper Pleistocene at San Quintin Bay, Lower California, Mexico, as *cameronis* (Dall, 1921, as Pliocene or Pleistocene; Jordan, as upper Pleistocene).

Recent: San Pedro, California, to Todos Santos Bay, Lower California, Mexico (Jordan).

This large *Mactra* differs from *catilliformis* in the long anterior portion of the shell, which is concave in profile along the dorsal margin. The hinge is of the same type as that of *catilliformis* but the laterals are a little longer. Also, the pallial sinus of *hemphilli* is more inclined upward. *M. hemphilli* is closely related to *catilliformis*.

According to Dall (Amer. Journ. Sci., Ser. 5, Vol. 4, p. 311, 1922) "*Spisula hemphilli* Dall" of Reagan (Trans. Kansas Acad. Sci., Vol. 22, p. 212, pl. 4, fig. 43, 1909) is an erroneous identification based upon a shell which Dall names "*Mulinia olympica*." Reagan reported his "*hemphilli*" abundant "in the Quillayute formation at the old mouth of Maxfield Creek." This is probably reworked Empire formation sandstone.

Spisula cameronis Dall was based upon a single specimen of a shell which appears to be a half-grown *hemphilli*, according to Dall's description and figure.

Mactra (Spisula) catilliformis (Conrad)

Plate 23, Figures 4, 10

Spissula catilliformis Conrad, Amer. Journ. Conch., Vol. 3, p. 193, 1867.

"*Standella californica* Conrad," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 640, 1864; not of Conrad, 1837, nor of Deshayes, 1852.

Mactra catilliformis Conrad, Dall, Nautilus, Vol. 7, p. 137, pl. 5, fig. 3, 1894; J. P. Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 172, 1912.

Spisula (*Hemimactra*) *catilliformis* Conrad, Dall, Nautilus, Vol. 8, p. 40, 1894; U. S. Nat. Mus., Bull. 112, p. 52, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 194, pl. 24, 1924; Strong, Nautilus, Vol. 38, 1925.

Mactra (*Spisula*) *catilliformis* Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 176, pl. 19, fig. 5, 1903.

Spisula catilliformis Conrad, var. *alcatrazensis* Arnold, Smithsonian Misc. Coll., Vol. 50, p. 19, pl. 56, fig. 6, 1907.

Spisula catilliformis Conrad, Keep, West Amer. Shells, p. 166, fig. 83, 1911; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Clark, Vol. 8, p. 420, pl. 59, fig. 1, 1915; Martin, Vol. 9, p. 254, 1916; Packard, Vol. 9, p. 285, pls. 17, 18, 19, 1916; Univ. Calif. Publ. Zool., Vol. 14, p. 282, pl. 24, fig. 2, pl. 27, figs. 1, 2, 1918; Oldroyd, Univ. Wash., Publ. Puget Sound Biol. Sta., Vol. 4, p. 59, pl. 39, fig. 1, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

? *Spisula mercedensis* Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 286, pl. 20, 1916.

Type locality: "Panama," according to Conrad; Recent.

Miocene: Temblor formation, middle Miocene of California (J. P. Smith); lower Neocene; upper and lower San Pablo and Santa Margarita formations, upper Miocene of middle California (Clark); ? Santa Margarita formation north of Coalinga (Nomland, questionably identified).

Pliocene: Lower Fernando of Holser Canyon, Los Angeles County (English); Etchegoin formation of middle California (Clark); rather common in the *Cryptomya californica* zone, lower Etchegoin, of well cores in the southern end of the San Joaquin basin near Bakersfield and near Tipton, also found higher in the section (H. R. Gale); middle part of Wildcat formation, Humboldt County; Purisima and Merced formations of San Francisco region (Martin); Pacific Beach, San Diego (Arnold, 1903).

Pleistocene: Barlow's Ranch, near Ventura; upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island, "rather common;" Pleistocene of Pacific Beach, Spanish Bight, and San Diego (Arnold, 1903); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Neah Bay to San Diego, California (Dall, 1921); Panama range denied by Dall.

This is a large, thin shell with moderately anterior beaks and a deep pallial sinus. Individuals attain a length of 130 mm., but the average specimen measures about 110 mm. in length and 85 mm. in height. *Mactra hemphilli* Dall has also a large shell, but the anterior portion of the valves protrudes much farther than do those of *catilliformis* and the anterior dorsal margin is concave. The hinges are similar, but *catilliformis* has shorter laterals.

Mactra (Spisula) mercedensis Packard is an unusual variant of *catilliformis*. It occurs at its type locality near Mussel Rock (lower part of the Merced formation), at the south end of Seven Mile Beach, San Mateo County, with normal forms of *catilliformis*, and also in the Etchegoin formation of well cores from the southern part of the San Joaquin basin near Tipton, Formosa, and Bakersfield. If it is to be separated as a variety, the distinguishing character will be the unusually anterior beaks; but its association with the typical form suggests that it is but an unusual individual variation. Similar variations in the position of the beaks occur in other species, for example *M. polynyma*, var. *voyi*.

Mactra (? Spisula) sisquocensis (Arnold)

Spisula sisquocensis Arnold, Smithsonian Misc. Coll., Vol. 50, p. 437 (Pt. 4, p. 19), pl. 56, fig. 1, 1907; Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 302, 1916.

Type specimen: In the U. S. National Museum, Catalogue No. 165,292.

Type locality: Alcatraz Asphalt mine, near Sisquoc, Santa Barbara County.

Pliocene: "Fernando formation, lower Pliocene portion," at the type locality (Arnold).

According to Arnold, "This species is near *S. hemphilli* Dall, but is constantly and decidedly narrower." The hinge is as yet unknown.

Mactra (? Spisula) coalingensis Arnold

Mactra coalingensis Arnold, U. S. Geol. Surv., Bull. 396, p. 71, pl. 25, fig. 4, Jan. 15, 1910; Bull. 398, pl. 47, same figure, 1910.

Spisula coalingensis Arnold, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 254, 1916; Packard, Vol. 9, p. 301, pl. 27, fig. 8, 1916; Nomland, Vol. 10, p. 220, 1917.

Type specimen: In the U. S. National Museum, Catalogue No. 165,513.

Type locality: Glycymeris bed on north side of Alcalde Canyon, two miles northeast of Alcalde, Coalinga district; Pliocene.

Pliocene: Etchegoin formation of Coalinga district (Arnold); Merced of Sargent oil field (Martin); upper Sargent (Nomland).

This species was compared to *falcata*, but the hinge has not been seen. It is said to be less ventricose than *albaria.*

A number of Mactras have been described from the earlier Tertiary formations of California, but as they have been discussed and figured by Packard or by later authors they need not be mentioned here. *"Spisula" longa* Dall, from the Pleistocene of Lower California, Mexico, is a *Schizothærus* and will be discussed under that genus.

Subgenus **MULINIA** Gray, 1837

Mulinia Gray, Proc. Zool. Soc. London for 1836, p. 104, February, 1837, *nomen nudum;* Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 375, July, 1837; Dall, Nautilus, Vol. 8, p. 27, 1894; Proc. Malac. Soc. London, Vol. 1, p. 211, 1895.

Type (by original designation), *Mulinia typica* Gray, = *Mactra edulis* King and Broderip, Zool. Journ., Vol. 5, p. 335, July, 1832; Patagonia and Straits of Magellan.

Shape like that of *Mactra, s. s.*, but with the ligament entirely internal and not separated from the chondrophore by a shelly ridge.

There has been some misunderstanding of the true characters of *Mulinia* Gray, probably because of unfamiliarity with Gray's original description in Loudon's Magazine of Natural History. In 1856 Conrad described a very heavy and ventricose Mactroid shell under the name of *Mulinia densata.* Later Gabb stated that Conrad had confused two species, and went on to apply *Mulinia densata* to a form which he described as possessing a thin shell and slender teeth. What he figured can hardly be Conrad's species. Other authors have used the name, *Mulinia densata* Conrad, for Conrad's original heavy-shelled species, which Gabb appears to have renamed *Schizodesma abscissa.* This confusion is pointed out here, as it illustrates the introduction of the very improper use of *Mulinia* for the grotesque, heavy, Mactroid shells that should be classified under *Pseudocardium* Gabb.

Mulinia was described by Gray as follows:

> "Shell ovate, trigonal, subangular at each end. Cardinal and lateral teeth like *Mactra.* Siphonal inflection ovate, distinct. Ligament internal ! in a triangular groove in the upper surface of the deep cartilage pit, quite hid from view."

Mactra (Mulinia) pallida Broderip and Sowerby

Plate 22, Figures *7a*, *7b*, *7c*

Mactra pallida Broderip and Sowerby, Zool. Journ., Vol. 4, p. 360, 1829; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 175, 304, 1857.

Mulinia donaciformis Gray, Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 376, July, 1837; Sowerby, Zool. Beechey's Voy., Moll., p. 154, pl. 44, fig. 13, 1839; ? C. B. Adams, Ann. Lyceum Nat. Hist., New York, Vol. 5, p. 517, 1852; Conrad, Amer. Journ. Conch., Vol. 3, Appendix, p. 31, 1868.

Mactra carinulata Deshayes, in Reeve, Conch. Icon., Vol. 8, *Mactra,* pl. 10, fig. 38, April, 1854; Deshayes, Proc. Zool. Soc. London for 1854, p. 67, February 10, 1855, young specimen ?.

Mactra goniata Gray, MS., Deshayes, Proc. Zool. Soc. London for 1854, p. 70, February 10, 1855; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 287, 304, 1857.

Mactra angulata Gray, MS., Reeve, Conch. Icon., Vol. 8, *Mactra*, pl. 9, fig. 34, April, 1854; Lamy, Bull. Mus. Hist. Nat. Paris, Vol. 14, p. 51, 1908.

Mactra donaciformis Gray, Reeve, Conch. Icon., Vol. 8, *Mactra*, sp. 62, pl. 13, fig. 60, not figure 62, April, 1854.

Mactra (*Mulinia*) *angulata* Gray, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., pp. 52, 549, 1855-57; Brit. Assn. Adv. Sci., Rept. for 1856, p. 246, 1857.

Mulinia angulata Gray, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 380, 1856.

Mulinia carinulata Deshayes, H. and A. Adams, *op. cit.*, p. 380, 1856.

Mulinea angulata Gray, Conrad, Amer. Journ. Conch., Vol. 3, Appendix, p. 31, 1868.

Mulinea carinulata Deshayes, Conrad, *op. cit.*, p. 31, 1868.

Mulinea donaciformis Gray, Conrad, *op. cit.*, p. 31, 1868.

Mulinia pallida Broderip and Sowerby, Dall, Nautilus, Vol. 8, p. 41, 1894; Proc. U. S. Nat. Mus., Vol. 37, p. 274, 1909.

Shell of moderate size, ventricose, the anterior end short, broadly rounded, the posterior produced and acutely rounded at the ventral end, flattened considerably in a broad posterior area from the end of the umbo to the posterior ventral point of the valve, producing an angulation similar to that on *Mactrella;* sculpture absent except for growth lines; hinge normal, chondrophore deep; pallial sinus rather small. Measurements: Length, 60 mm.; height, 43 mm.; convexity of one valve, 17 mm. (large specimen from Panama).

Type locality: San Blas, Tepic, Mexico; Recent.

Broderip and Sowerby described *Mactra pallida* from Recent specimens collected at San Blas, west coast of Mexico. In 1837 Gray briefly described *Mulinia donaciformis*, which he stated came from the "South Seas." This species was figured by Sowerby in the Zoology part of the report on Beechey's Voyage and was said to have come from the Isle of Nevis in the Antilles, where Beechey did not land. Reeve (1854) figured *donaciformis*, but attributed it to New Zealand, which is certainly an error. C. B. Adams (1852) questionably identified some Panama shells with *donaciformis*, basing his identification on the small figures in Hanley's supplement to Wood's Index Testaceologicus.

Comparison of a small series of Donaciform Mulinias from the southern fauna with plates of the "species" included in the above synonymy (where figured) indicates that the name *pallida* should be used for the somewhat variable but characteristically ventricose, high beaked, posteriorly pointed shells which range from the Gulf of California to Ecuador. In view of the amount of variation shown in the collections, it may be necessary to include several other supposed species in the synonymy of *pallida*.

Mactra (Mulinia) pallida Broderip and Sowerby variety **modesta** (Dall)

Mulinia modesta Dall, Nautilus, Vol. 8, p. 5, pl. 1, lower figure, May, 1894; p. 41, Aug., 1894.

Mulinia coloradoensis Dall, *op. cit.*, p. 6, pl. 1, upper figure; May, 1894; p. 41, Aug., 1894.

Mulinia coloradoensis, var. *acuta* Dall, *op. cit.*, p. 6, pl. 1, left figure, May, 1894; p. 41, Aug., 1894.

"*Mactra exoleta* Gray," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 175, pl. 19, fig. 4, 1903; not *Mactra exoleta* Gray, Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 372, 1837.

"*Mactra* (*Mactrella*) *exoleta* Gray," Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 281, pl. 12, figs. 4*a*, 4*b*, pl. 13, fig. 2, 1916; not of Gray.

Shell small or of moderate size, ovate-triangular, and similar to *pallida*, but generally not so acutely pointed at the posterior ventral end and generally with broader, less prominent umbones, and less abrupt flattening of the posterior portion of the valves. Size: Length, 42 mm.; height, 31 mm.; convexity of both valves together, 24 mm.

Type specimens: In the U. S. National Museum.

Type localities: Of *modesta*, Guaymas, Mexico, Recent; of *coloradoensis*, estuary of the Colorado River, head of the Gulf of California, Mexico, Recent; of variety *acuta*, same as *coloradoensis*.

Pleistocene: Lower Pleistocene at Signal Hill (T. S. Oldroyd collection); upper San Pedro series of San Pedro, "rare" (Arnold); Newport, Los Angeles County (Packard); Spanish Bight and Pacific Beach, San Diego (Arnold); lower Quaternary, Magdalena Bay, Lower California, Mexico (E. K. Jordan).

Recent: Lower California and the Gulf of California, Mexico.

Arnold's figured specimen of "*Mactra exoleta* Gray" is in the geological museum at Stanford University. It belongs to the subgenus *Mulinia* and is very close to *M. pallida*, though it appears to be less pointed posteriorly. There are three specimens of the same form in the T. S. Oldroyd collection of Pleistocene fossils from Signal Hill (= "Los Cerritos" of Arnold), Los Angeles County. Packard discusses *Mactra exoleta* Gray, carefully describing the "well-developed shelly ridge" separating the ligament from the chondrophore; but he figures a specimen that is clearly a *Mulinia*, with a hinge very different from that of *Mactra exoleta*. There is little doubt that the shell figured by Packard represents the same form as the shell figured by Arnold. Both have a remote external resemblance to *Mactra exoleta*, but a comparison of specimens shows that the latter species is entirely different. The true *Mactra exoleta* has an exceptionally prominent shelly partition separating the chondrophore from the external ligament, whereas the present species has an entirely internal ligament attached to the upper wall of the chondrophore. Also, the posterior dorsal margin of *M. exoleta* descends abruptly, making almost a right angle with the anterior drosal margin, and causing the posterior lateral teeth to be relatively very much shorter. *M. exoleta* attains a much larger size than does *pallida;* a large specimen in the Stanford collection from the coast of Guerero, Mexico, has a length of 118 mm., a height of 85 mm., and a convexity (one valve) of about 30 mm. The ligament diverges anteriorly from the valve margin in a narrow slit extending to a point beneath the umbo. It belongs to the group *Mactrella* Gray.[1] Although *Mactrella exoleta* has not yet been reported fossil in California, a specimen is shown on plate 22, figures 10*a*, 10*b*, for comparison.

Mactra modesta (Dall), *M. coloradoensis* (Dall), and its variety *acuta* (Dall) are probably variations within a single variety of *pallida*. The amount of variation exhibited by *pallida* suggests that all three of these forms named by Dall are very closely related and are hardly worthy of separate names. Dall's figures, especially of *modesta* and of *coloradoensis*, are so similar to the *Mulinia* figured by Arnold, to the figures of *exoleta* given by Packard, and to the specimens collected by Mr. Oldroyd that they are all here identified as the variety *modesta* of *pallida*.

Subgenus **PSEUDOCARDIUM** Gabb, 1866

Pseudocardium Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 20, 21, 1866.

Type (by monotypy), *Pseudocardium gabbii* (Rémond), = *Mulinia densata* Conrad; Miocene and Pliocene of California.

Shell thick, heavy, ventricose, quite variable in shape, generally high, with strongly curved umbones; sculpture of irregular, course growth lamellæ; hinge Mactroid, heavy, with a deep chondrophore, ligament external, extending into chondrophoric cavity and often produced in a slit that descends from the valve margin to a point below the umbo; laterals well developed, often very large; pallial sinus rather short, rounded at end.

Geologic range: Oligocene (or upper Eocene) to middle Pliocene.

Gabb introduced the genus *Pseudocardium* for the heavy-shelled, ventricose Mactroid species which Rémond had described as "*Cardium gabbii*" but which had previously been named "*Mulinia*" *densata* by Conrad. Gabb recognized the characters of *Mulinia* Gray, but misconstrued Conrad's species *densata*, applying that name to some thin-shelled species. Although Conrad's description of "*Mulinia*" *densata* is short and his figure none too good, it is apparent that he could not have had any thin-shelled species with slender teeth, for he described his form as being "ventricose, thick," and as having the "lateral teeth very robust and prominent." Gabb may have been misled by the peculiar shape of Conrad's figure, but very inequilateral specimens of *densata* occur in any large collection. One is figured by Packard. Unfortunately, Gabb renamed the true *densata* as *Schizodesma abscissa*.[1] *Schizodesma* Gray, or more properly *Scissodesma*,[2] is typically a trigonal shell with small, distant umbones, a very wide cardinal area, and a ligament in a triangular slit which opens below into the chondrophore and extends upward away from the valve margin at a large angle, the sharp point ending under the apex of the umbo. *Scissodesma* has little in common with *Pseudocardium* other than characters which are due to its membership in the Mactroid group. The ligament slit continuing almost to the umbo is a feature exhibited by a number of species of *Mactra* which are not closely related according to their other characters, and the deep chondrophore of *Pseudocardium* is a function of the ventricosity and the thickness of its shell. The powerful lateral teeth of *Pseudocardium* are likewise the result of the heavy shell, which requires a correspondingly rigid mechanical construction of the hinge, and are not like the stout lateral teeth of *Scissodesma*, which are thick to make up for their shortness.

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[1] Ann. Mag. Nat. Hist., Ser. 2, Vol. 11, p. 42, January, 1853, monotype, *M. striatula* Linnæus, Syst. Nat., Ed. 12, p. 1125, 1767 (? = *M. alata* Spengler, + *M. carinata* Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 473, 1818); H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 377, 1856.

With sufficient material it may be possible to show that *Pseudocardium* represents a *Mactra*, *s. s.*, or a *Spisula*, perhaps *M. albaria*, that has been distorted by peculiar ecologic conditions. The extreme abundance of the type species concentrated in beds practically by itself is suggestive of brackish water conditions.

Mactra (Pseudocardium) densata (Conrad)

Mulinia densata Conrad, Proc. Acad. Nat. Sci. Phila. for 1856, p. 313, 1856; U. S. Pac. R. R. Repts., Vol. 6, p. 71, pl. 3, fig. 12, 1857; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 252, 1888; Arnold, U. S. Geol. Surv., Bull. 396, pp. 140, 148, pl. 17, figs. 3, 4, pl. 21, fig. 3, Jan. 15, 1910; Bull. 398, pl. 39, figs. 3, 4, pl. 43, fig. 3, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp 590, 593, 594, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 418, 1915; Packard, Vol. 9, pp. 304, 305, pls. 29-33, 1916; Nomland, Vol. 10, p. 219, 1917; Howe, Vol. 14, p. 92, 1922; Hoots, Bull. 812-D, U. S. Geol. Surv., p. 278, 1930; not "*? M. densata* Conrad" of Gabb, 1866.

Cardium gabbii Rémond, Proc. Calif. Acad. Sci., Vol. 3, p. 13, 1863.

Schizodesma abscissa Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 20, pl. 4, figs. 34, 34*a*, 1866; Hoots, Bull. 812-D, U. S. Geol. Surv., p. 284, 1930.

Pseudocardium gabbii Rémond, Gabb, *op. cit.*, p. 21, pl. 6, figs. 47, 47*a*, 47*b*, 47*c*, 47*d*, 1866.

Mulinia oregonensis Dall, U. S. Geol. Surv., Prof. Paper 59, p. 132, pl. 9, figs. 2, 3, pl. 13, fig. 5, 1909.

? Mulinia densata Conrad, var. *minor* Arnold, U. S. Geol. Surv., Bull. 396, p. 54, pl. 5, fig. 6, January 15, 1910; Bull. 398, pl. 27, same figure, 1910.

Spisula abscissa (Gabb) Packard, Univ. Calif. Publ. Geol., Vol. 9, p. 289, pl. 23, fig. 4, pl. 24, fig. 2, 1916.

Pseudocardium gabbi, Pack, Prof. Paper 116, U. S. Geol. Surv., p. 45, 1920.

Type locality: Santa Barbara or shores of San Pablo Bay; Miocene.

Miocene: ? Vaqueros formation, lower Miocene (Arnold, var. *minor*); Empire formation of Oregon (Arnold and Hannibal; Dall, as *M. oregonensis*); San Pablo formation of middle California (Clark); Santa Margarita formation, upper Miocene (Nomland).

Pliocene: Coos conglomerate (Dall; Howe); Etchegoin formation (Arnold; Nomland); Etchegoin of the southeastern end of the San Joaquin basin (Pack, as *gabbi;* Hoots, as *densata* and *abscissa);* Merced and Purisima formations of middle California (Arnold and Hannibal; etc.).

This species has been discussed above under the subgenus *Pseudocardium*. It has been well figured by Arnold and Packard and need not be described here. It is hoped that it will no longer be classed as a *Mulinia*.

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[1] Gabb., *op. cit.*, p. 20, pl. 4, figs. 34, 34*a*, 1866.

[2] Gray, Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 370, 1837, *S. spengleri* included and figured; Proc. Zool. Soc. London for 1847, p. 185, 1847, spelling changed to *Schizodesma*, *S. spengleri* designated as type.

Packard considered *Schizodesma abscissa* a *Spisula*, but the present authors believe that it is but a variant of *densata* not entitled to a varietal name.[1]

Genus **SCHIZOTHAERUS** Conrad, 1853

Cryptodon Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 235, 1837; not *Cryptodon* Turton, Conch. Insul. Brit., p. 121, 1822; nor *Cryptodon* Latreille, 1833.

Tresus Gray, Ann. Mag. Nat. Hist., Ser. 2, Vol. 11, p. 44, January, 1853; Dall, Nautilus, Vol. 8, p. 42, 1894; Proc. Malac. Soc. London, Vol. 1, p. 212, 1895; Trans. Wagner Inst. Sci., Vol. 3, p. 885, 1898; Lamy, Journ. de Conchyl., Ser. 4, Vol. 17, p. 378, 1917; not *Tresus* Walckenær, Ann. Soc. Ent. France. Vol. 2, 1833, *Arachnida*.

Schizothærus Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 6, p. 199, January, 1853.

Type (by monotypy), *Schizothærus nuttallii* (Conrad), 1837; shores of north Pacific Ocean, also fossil.

Shell ovate, oblong, ventricose, hinder gape roundish; hinge with the cardinal teeth small, lateral teeth very small, close to the cardinals; ligament external, marginal, separated from the cartilage-pit by a shelly plate. (Gray's description of *Tresus*.)

Schizothærus is a small genus of Mactroid shells modified by the burrowing habit of the animal. There is only one known valid living species, with possibly a few varieties. It may have been derived from *Mactra catilliformis* or some similar species in the Miocene.

Schizothærus nuttallii (Conrad)

Plate 22, Figure 9; Plate 23, Figures 8*a*, 8*b*, 9

Lutraria (*Cryptodon*) *nuttallii* Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 235, pl. 18, fig. 1, 1837.

Cryptodon nuttallii Conrad, Gray, Proc. Zool. Soc. London for 1847, p. 185, 1847; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 194, 300, 349, 1857; Rept. for 1863, pp. 525, 586, 1864.

Lutraria maxima Middendorff, Mém. Acad. Imp. Sci. St.-Petersbourg, Ser. 6, Vol. 6, p. 560, pl. 19, figs. 1-4, 1849; Reeve, Conch. Icon., Vol. 8, *Lutraria*, pl. 5, fig. 18, 1855; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 192, 209, 219, 224, 300, 1857; Rept. for 1863, p. 600, 1864.

Lutraria capax Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 217, 1850; U. S. Expl. Exped. (Wilkes), Moll., p. 395, 1852, Atlas, pl. 34, fig. 508, 1856; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 209, 213, 1857; Rept. for 1863, p. 531, 1864.

Tresus maximus Middendorff, Gray, Ann. Mag. Nat. Hist., Ser. 2, Vol. 11, p. 42, 1853; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 381, 1856; Chenu, Man. Conchyl., Vol. 2, p. 59, fig. 243, 1862; Conrad, Amer. Journ. Conch., Vol. 3, Appendix, p. 46, 1868.

Lutraria inflata Dunker, Zeitschr. f. Malak., Vol. 10, p. 112, 1853; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 296, 1857.

Schizothærus nuttallii Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 6, p. 199, 1853; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 525, 586, 1864; Tryon, Struct. Syst. Conch., Vol. 3, p. 161, pl. 110, fig. 21, 1884; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 264, 1888, "*Schizothaerus;*" Thompson, Rept. B. C. Commissioner of Fisheries for 1912, pp. I-39, I-47, pl. 5, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, 1915; Martin, Vol. 9, p. 254, 1916; Packard, Vol. 9, pl. 35, 1916; Nomland, Vol. 10, pp. 303, 304, 1917; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 283, pl. 28, figs. 1*a*, 1*b*, 1918; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 54, pl. 16, fig. 3, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 52, 1921; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 564, 1922; Oldroyd, Univ. Wash., Publ. Puget Sound Biol. Sta., Vol. 4, p. 60, pl. 33, figs. 1*a*, 1*b*, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 196, pl. 31, figs. 1*a*, 1*b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 255, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Mactra maxima Middendorff, Reeve, Conch. Icon., Vol. 8, *Mactra*, pl. 1, fig. 4, 1854.

Lutraria nuttallii Conrad, Lischke, Japanische Meeres-Conchyl., Vol. 1, p. 136, 1869; Vol. 2, p. 123, 1871.

Tresus nuttallii Conrad, Dunker, Index Moll. Maris Japonici, p. 184, 1882; Dall, Nautilus, Vol. 8, p. 42, 1894; Proc. Malac. Soc. London, Vol. 1, p. 212, 1895; Trans. Wagner Inst. Sci., Vol. 3, p. 885, 1898; Lamy, Journ. de Conchyl., Ser. 4, Vol. 17, pp. 379, 380, text figures, 1917.

Schizothærus nuttallii capax Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 52, 1921; Oldroyd, Univ. Wash., Publ. Puget Sound Biol. Sta., p. 61, 1924; Stanford Univ. Publ. Geol., Vol. 1, p. 196, 1924.

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[1] Stewart figures Gabb's type of *abscissa* (Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 210, pl. 16, fig. 6, 1930) and proposes for it the new name *Stereomactra*, which thus becomes a synonym of *Pseudocardium*.

Spisula longa Dall, West American Scientist, Vol. 19, p. 22, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 27, pl. 10, fig. 1, pl. 11, fig. 3, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 244, 1926.

Schizothærus cf. *pajaroensis* Conrad, Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922.

"*Mactra nasuta* Gould," of Pacific coast collectors, probably not of Gould, 1851.

Shell large, elongate-ovate, ventricose, with anterior beaks, posterior gape broad; pallial sinus confluent at base with pallial line.

Type localities: Of *nuttallii*, near Santa Barbara, Recent; of *capax*, Puget Sound, Recent; of *longa*, San Quintin Bay, Lower California, Mexico, Pleistocene.

Miocene: Montesano ?, upper Miocene of western Washington (Howe); Empire formation of Coos Bay region, Oregon (Dall, 1909); lower San Pablo, upper Miocene of middle California (Clark); questionably at type section of Santa Margarita formation, Nacimiento River (Nomland, 1917); Santa Margarita, Miocene (Clark).

Pliocene: Merced and Purisima formations in region south of San Francisco (Arnold and Hannibal; Martin); Wildcat formation of Humboldt County (Martin); Merced formation near Freestone, Sonoma County (Dickerson); Jacalitos and Etchegoin formations of Coalinga region (Clark); *Chione elsmerensis* and *Turritella nova* zones, lower part of the Pliocene near Coalinga (Nomland); Santa Barbara (Cooper); lower "Pico" near Ventura (Waterfall).

Pleistocene: Santa Barbara to San Diego (Cooper); Los Cerritos (Arnold); rare in lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); Tomales Bay, Marin County (Dickerson); upper Pleistocene at Campbell Ranch, southwest of Goleta, Santa Barbara County, S. D. S. N. H. localities 40 and 74 (F. N. Johnston, U. S. Grant, collectors); upper San Pedro series at San Pedro, Crawfish George's, and San Pedro; also at Spanish Bight, San Diego (Arnold); "Saugus," near Ventura (Waterfall); Pleistocene of San Quintin Bay (as "*Spisula longa*" Dall, 1919; as *Schizothærus nuttallii* Conrad, Jordan).

Recent: Cordova, Prince William Sound, Alaska (McMillin); south to Scammons Lagoon, Lower California, Mexico (Jordan); also, northern Japan (Lischke; Dunker; etc.).

This species is easily recognized by its large size, ventricosity, rounded posterior gape, strong chondrophore, and very small, short lateral teeth. *Lutraria maxima* and *L. capax* are unquestionable synonyms. Dall sought to use *capax* for the very short, high, subglobose variants, but Gould's type figure is of a typical *nuttallii*. The original description of *Lutraria inflata* has not been consulted, but it refers to a living California *Schizothærus* of which there is but one species. "*Spisula*" *longa* Dall is a young *nuttallii*, according to Dall's figures.

Mactra nasuta Gould (Proc. Boston Soc. Nat. Hist., Vol. 4, p. 88, 1851), which was stated to inhabit Mazatlan, Mexico, and San Pedro, California, may be a rare species which is now not definitely known. The shells in California collections which are labeled *M. nasuta* generally prove to be the young of *Schizothærus nuttallii*.

Schizothærus nuttallii (Conrad) variety **pajaroanus** (Conrad)

Plate 22, Figures 6*a*, 6*b*, 8

Venus pajaroana Conrad, U. S. Pacific R. R. Repts., Vol. 7, Pt. 1, p. 192, pl. 4, figs. 1, 2, 1857.

Schizothærus pajaroanus Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 130, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 593, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 420, 1915; Martin, Vol. 9, pp. 239, 243, 245, 254, 1916; Howe, Vol. 14, p. 92, 1922.

Shell averaging smaller than that of typical *Schizothærus nuttallii*, less ventricose, with smaller, less rounded posterior gape, and with umbones often more anterior in position.

Type specimen: In the U. S. National Museum, No. 13,318.

Type locality: "Pajaro River, Santa Cruz" (Conrad).

Miocene: Montesano, middle Miocene of Washington; Empire formation, Coos Bay, Oregon (Dall, 1909; Arnold and Hannibal; Howe); lower San Pablo of middle California (Clark, 1915).

Pliocene: Coos Conglomerate of Coos Bay, Oregon, questionably (Howe); Purisima and Merced formations in region south of San Francisco (Arnold; Martin); Etchegoin of Coalinga region; Wildcat formation of Humboldt County (Martin).

This variety is readily distinguished by its smaller size, less ventricose valves, and smaller, less rounded posterior gape. Conrad's figures suggest *Clementia pertenuis* (Gabb), but his type specimen is a *Schizothærus.*

Genus ANATINA Schumacher, 1817

? *Anatina* Renier, 1804, *nomen nudum.*

Not *Anatine* Lamarck, 1809 and 1812, vernacular use only, *fide* Iredale, Proc. Malac. Soc. London, Vol. 11, p. 304, 1915.

Anatina Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 125-126, 1817.

Not *Anatina* Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 462, 1818.

Labiosa Schmidt, in Möller, Isis (Oken), p. 130, 1832 (? Schmidt, Vers. Einth. Conch., 1828); Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 881, 882, 906, 1898; Lamy, Journ. de Conchyl., Ser. 4, Vol. 17, p. 348, 1917.

Type (by monotypy), *Anatina pellucida* Schumacher, *op. cit.* p. 126, pl. 8, fig. 1, 1817, = *Mactra anatina* Spengler, Skrift. Naturh. Selsk., Vol. 5, Pt. 2, p. 120, 1802; figured by Gray, in Wood, Index. Test., Suppl., pl. 1, fig. 1, 1828, as *Mactra cyprinus* Gray; habitat, ? Pacific coast of Mexico.

Shell small or medium in size, thin-shelled, ventricose, beaks adjacent, posterior gaping, laterally somewhat flattened, sub-rostrated; sculpture consisting of fine growth lines only or of growth lines and concentric undulations; hinge with prominent chondrophore; cardinal teeth small but definitely formed, partly overhanging the chondrophore; anterior lateral obsolete, posterior small and short; hinge plate excavated in front of cardinals, flattened behind; ligament separated from chondrophore by a shelly wall; pallial sinus short, broad, not confluent below with the pallial line.

Geologic range: Miocene to Recent.

Anatina S. Renier[1] is said to be a nude name, and *Anatina* Lamarck, 1809[2] and 1812, are erroneous references, according to Iredale, as both refer to vernacular usages of the generic name. *Anatina* Lamarck, 1818, is a year later than Schumacher's *Anatina* and refers to a different shell. *Labiosa* Schmidt is much later and must be considered a synonym. We propose to use *Anatina* for the almost smooth group as well as for the inflated shells with prominent concentric ripples. *Anatina, sensu stricto,* will include only the shells that are almost smooth, having merely fine growth lines. These shells are generally smaller in size.

The hinge of *Anatina* is suggestive of *Schizothærus.* The latter, however, is larger and much heavier-shelled.

Subgenus **ANATINA**, s. s.

Shell sculptured with concentric striations, posterior end rostrated, with a radial ridge or plication descending from the umbo to the posterior ventral margin, and with the posterior dorsal margin reflected outward.

Geologic range: Pliocene to Recent.

The Pacific coast typical Anatinas are not well known. They may be represented by the type in the Recent fauna and by *transmontana* in the fossil. *Anatina* (*Anatina*) *lineata* (Say), of the Atlantic coast, occurs in the Pliocene of Florida.

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[1] Tavole per servire alla Classificazione e Connoscenza degli Animali, table 7, Padova, 1804, *nomen nudem, fide* Sherborn.

[2] Philosophie Zoologique, p. 319, 1809.

Subgenus **RAËTA** Gray, 1853

Raëta Gray, Ann. Mag. Nat. Hist., Ser. 2, Vol. 11, p. 43, January, 1853; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 386, 1856; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 882, 1898.

Type (by monotypy), *R. campechensis* (Gray), 1825, = *Lutraria canaliculata* Say, 1822, = *Lutraria plicatella* Lamarck, 1818; New Jersey to Brazil; also Pleistocene of Florida.

Shell rather large, convex, compressed posteriorly; sculpture of concentric plications, surface of fresh specimens vermiculate.

Geologic range: Miocene to Recent.

The most distinctive difference between *Raëta* and *Anatina*, *s. s.*, is in the presence of evenly-spaced, concentric plications on the former in addition to the fine growth lines on the latter. The radial plication on the posterior portion of *Anatina*, *s. s.*, is moved very near the posterior dorsal margin and is much subdued in *Raëta*. The dorsal margin of typical *Raëta* is not reflected.

Anatina (Raëta) undulata (Gould)

Plate 23, Figures *5a*, *5b*, *5c*

Lutraria undulata Gould, Proc. Boston Soc. Nat. Hist., Vol. 4, p. 89, 1851; Boston Journ. Nat. Hist., Vol. 6, pp. 391, 392, pl. 15, fig. 7, 1853; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 211, 227, 232, 1857.

Raëta undulata Gould, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 386, 1856; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 535, 614, 640, 681, 1864.

Labiosa undulata Gould, Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 157, 1894; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 191, pl. 21, fig. 11, 1924.

Labiosa (*Raëta*) *undulata* Gould, Dall, Nautilus, Vol. 8, p. 41, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 177, 1903; Lamy, Journ. de Conchyl., Ser. 4, Vol. 11, p. 249, 1909; Vol. 17, p. 355, 1917.

Anatina undulata Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 51, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924.

Type locality: La Paz, Lower California, Mexico; Recent.

Pleistocene: Questionably in the lower San Pedro series of Deadman Island, one "small fragment;" upper Pleistocene at Spanish Bight, San Diego (Arnold); upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).

Recent: San Pedro, California, to Panama (Dall, 1921).

Recent specimens of this species from La Paz, Lower California, Mexico, the type locality, have the umbones noticeably anterior to the middle of the shell. In the Stanford collection specimens labeled "San Pedro" which look like Pleistocene fossils have the umbones nearly medial. The Miocene form described below has the umbones posterior to the middle, being in this respect more like the Atlantic *Anatina plicatella* (Lamarck). The largest specimen of *undulata* we have seen came from La Paz and measures 119 mm. in length, 89 mm. in height, and the right valve has a convexity of about 32 mm. The concentric ripples are almost obsolete on the later formed parts of the shell.

Anatina (Raëta) plicatella (Lamarck)

Lutraria plicatella Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 470, 1818; Deshayes and Milne-Edwards Ed., Vol. 6, p. 93, 1835; Lamy, Bull. Mus. Hist. Nat., Vol. 19, p. 347, 1913.

Lutraria canaliculata Say, Journ. Acad. Nat. Sci. Phila., Vol. 2, p. 311, 1822; Conrad, Amer. Mar. Conch., p. 46, pl. 10, fig. 1, 1831; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 211, 364, 1857.

Mactra campechensis Gray, 1825 (?); in Wood, Index Testac. Suppl., pl. 1, fig. 3, 1828.

Lutraria campechensis Gray, Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 375, 1837.

Lavignon papyracea d'Orbigny, Voy. Amér. Mérid., Moll., p. 527, 1846, not of Chemnitz, *fide* Lamy, 1917.

Raëta campechensis Gray, Ann. Mag. Nat. Hist., Ser. 2, Vol. 11, p. 43, 1853.

Mactra canaliculata Say, Reeve, Conch. Icon., Vol. 8, *Mactra*, pl. 21, fig. 122, 1854.

Raëta canaliculata Say, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 386, pl. 102, fig. 44*a*, 1856; Chenu, Man. Conchyl., Vol. 2, p. 62, fig. 251, 1862; Carpenter, Proc. Zool. Soc. London, for 1863, p. 368, 1863; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 614, 640, 681, 1864.

Labiosa (*Raëta*) *canaliculata* Say, Dall, Nautilus, Vol. 8, p. 28, 1894; Trans. Wagner Inst. Sci., Vol. 3, pp. 882, 907, 1898.

Labiosa (*Raëta*) *plicatella* Lamarck, Lamy, Journ. de Conchyl., Ser. 4, Vol. 17, pp. 353, 354, pl. 7, fig. 6, 1917.

Shell with beaks posterior to medial point of valves; shape subovate, constricted behind.

Recent: Caribbean and western Atlantic.

Lamy (1917) has discussed this species and shown that *canaliculata* Say must fall into the synonymy of *plicatella* Lamarck. The type specimen of Lamarck's *plicatella* with the original label was found by Lamy in the Paris Museum and was figured by him in his Revision of the *Mactridæ*. It is possible that *Mactra papyracea* Chemnitz[1] is identical with Lamarck's *plicatella,* but Chemnitz's names are not strictly binomial in the volume in which *papyracea* is described. Chemnitz gave the habitat of his species as Nicobar, in the East Indies; but this may be an error, as incorrect localities are common in the works of the older authors. The figure given by Chemnitz is of a shell with a more evenly rounded posterior end than Lamarck's type of *plicatella* has or than Recent specimens from Florida have, but this difference might be due to errors of delineation on the part of Chemnitz.

All specimens as well as all figures of *Anatina plicatella* which we have seen show that the Atlantic species has posterior umbones and a rather ovate shape. The Pacific coast Recent *undulata* has anterior umbones; but the California Miocene form has posterior umbones like the eastern species, to which it is probably closely related.

Anatina (**Raëta**) **plicatella** (Lamarck) variety **longior,** new variety

Plate 23, Figures 1*a*, 1*b*

Shell like that of *Anatina plicatella* Lamarck but more elongate, less ventricose, with the posterior end more constricted, and an almost straight anterior dorsal margin. Length, 40 mm.; height, 25 mm.; convexity (left valve), about 8 mm.

Type specimen: San Diego Society of Natural History No. 192.

Type locality: Superior Oil Company well, Ansolabehere No. 1, in Sec. 9, T. 29 S., R. 27 E., Mt. Diablo B. and M., depth, 4,525-7 feet, near Bakersfield, Kern County, California, upper Miocene (H. R. Gale).

Miocene: At the type locality, upper Miocene of a well core near Bakersfield.

One well-preserved specimen of an *Anatina* was secured from the core of a well drilled near Bakersfield. It was associated with *Amiantis callosa* variety *stalderi* (Clark), *Glycymeris septentrionalis* (Middendorff), *Lucina nuttallii* Conrad, *Lucina excavata* Carpenter, *Macoma indentata* Carpenter (one specimen), *Panope generosa* Gould (one fragment), *Solen sicarius* Gould, *Corbula luteola* Carpenter, *Polinices reclusianus* (Deshayes), var. *callosus* (Gabb), *Polinices diabolensis* (Clark), *Calyptræa mamillaris* (Broderip), *Olivella pedroana* (Conrad), *Nassarius antiselli* (Anderson and Martin), *N. arnoldi* (Anderson), and *Mitrella tuberosa* (Carpenter). This specimen is more elongate, has a more constricted posterior end, and more posterior beaks than Conrad's *transmontana*.

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[1] Neues Syst. Conch. Cab., Vol. 6, pp. 233, 234, pl. 23, fig. 231, 1782.

A. transmontana has approximately central beaks and fine, somewhat discontinuous, concentric sculpture. In the variety *longior* the umbo is a little more than a third of the total length of the shell from the posterior end.

It is of much interest to note the closer relationship of this California Miocene *Anatina* with the Atlantic species than with the Pacific Recent *undulata*. It is a striking illustration of the Miocene intermigration between the Atlantic and Pacific faunas.

Anatina (Raëta ?) transmontana (Conrad)

Plate 22, Figure 2

Lutraria transmontana Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 8, p. 315, December, 1856; U. S. Pac. R. R. Repts., Vol. 7, p. 194, pl. 5, fig. 6, 1857; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 175, 184, 1909, reproductions of Conrad's descriptions.

Type specimen: No. 13,322 in the U. S. National Museum.

Type locality: "Rancho Triumpho, near Los Angeles;" Miocene.

Miocene: Rancho Triumfo near the boundary between Los Angeles and Ventura counties, probably in the Topanga formation, Temblor Miocene; "Shore between San Luis and Santa Barbara" (Conrad, 1857).

This species has approximately central beaks and numerous concentric growth lines. It does not seem to be closely related to the new form described above. Mr. S. Müller kindly compared the type of *longior* with Conrad's type of *transmontana* in the U. S. National Museum. It is possible that *transmontana* should be assigned to the typical subgenus of *Anatina*.

Conrad compared *transmontana* with his *Lutraria papyria*[1] from the Eocene of Alabama, but the hinge of the latter is supposed to be sufficiently different to form the basis of a different genus, *Pteropsis* Conrad, 1860.[2]

Genus RANGIA Desmoulins, 1832

Gnathodon Gray, in Sowerby, Gen. Shells, No. 36, Dec., 1831; Gray, Proc. Zool. Soc. London for 1836, p. 104; Loudon's Mag. Nat. Hist., New Series, Vol. 1, p. 376, 1838; Dall, Nautilus, Vol. 8, p. 27, 1894; Proc. U. S. Nat. Mus., Vol. 17, pp. 89-106, pl. 7, 1894; Gill, Nautilus, Vol. 8, pp. 102, 103, 1895; not *Gnathodon* Goldfuss, Handbuch der Zoologie, Abth. 2, p. 100, 1820, *fide* Gill. 1895.

Rangia Desmoulins, Actes Soc. Lin. Bordeaux, Vol. 5, No. 25, p. 50, Feb. 15, 1832; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 380, 1856; Fischer, Man. Conchyl., p. 1095, 1887; Gill, Nautilus, Vol. 8, pp. 102, 103, 1895.

Type (by subsequent designation, Gray, 1847), *Rangia cyrenoides* Desmoulins, = *Gnathodon cuneatus* Gray, in Sowerby, Gen. Shells, Pt. 36, figs. 1-3, 1831; also figured by Reeve, Conch. Syst., Vol. 1, p. 62, pl. 47, 1841; coast of Gulf of Mexico, Recent; also fossil in Pliocene of Florida, etc.

Shell somewhat like that of *Mulinia* Gray, but with the laterals elongated, the anterior one hooked downward at the cardinal end.

Geologic range: Tertiary to Recent, possibly Mesozoic.

Distribution: North, South, and Central America and the Caribbean region; ? Europe; in brackish or salt water.

This genus is a deformed derivative of the *Mactridæ* specialized for brackish-water conditions.

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[1] Fossil Shells of the Tertiary Formations of North America, Philadelphia, Vol. 1, no. 4, p. 41, 1833; reproduced by Harris, p. 67, (bottom pagination), pl. 19, fig. 1, 1893. According to Harris, the plate was never really published with the original text.

[2] Dall described and discussed this genus in Trans. Wagner Inst. Sci., Vol. 3, p. 881, 1898.

Rangia lecontei (Conrad)

Gnathodon lecontei Conrad, Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 2, p. 273, pl. 24, figs. 1-3, January, 1853; Proc. Acad. Nat. Sci. Phila., Vol. 7, p. 31.

Rangia leconti Conrad, Proc. Acad. Nat. Sci. Phila., for 1860, p. 232, 1861.

"*Gnathodon mendicus* Gould," Orcutt, West American Scientist, Vol. 12, p. 11, 1901; not of Gould, Proc. Boston Soc. Nat. Hist., Vol. 4, p. 88, 1851, as *Mactra*.

Type specimen: In the U. S. National Museum, Catalogue No. 6,833.

Type locality: Carrizo Creek, western Imperial County; Quaternary.

Quaternary: Carrizo Creek, western border of the Colorado Desert, Imperial County.

This species was reported in great abundance in a layer two feet thick along the bank of Carrizo Creek. It differs from *Rangia mendica* (Gould) in its elongate posterior lateral tooth and its more rounded shape. *Rangia mendica* (Gould) is the type of the section *Rangianella* Conrad, which is characterized by short lateral teeth that are feebly striated or smooth, by its somewhat elongate shape, and by its practically obsolete pallial sinus. *R. lecontei*, although it agrees in that its pallial sinus is obsolete, has the elongate teeth of typical *Rangia*.

Superfamily Myacea

Pelecypods usually with the burrowing habit, more or less inequivalve, hinges degenerate.

Family MYACIDAE

Shell with a large projecting spoon-shaped resilium-bearing process in the left valve and a shallow depressed socket in the hinge of the right corresponding to it; teeth usually obsolete.

Geologic range: Eocene to Recent.

Genus MYA Linnæus, 1758

Mya Linnæus, Syst. Nat., Ed. 10, p. 670, 1758, species included are *truncata*, *arenaria*, and several others; Children, Quart. Journ. Sci., Lit., Arts, Vol. 14, p. 85, October, 1822, type cited *Mya truncata* Linnæus; "*Mya* L., 1758*a*, 670, type *M. truncata* L., 1758*a*, 670" placed on the official list of generic names by Opinion 94 of the International Commission on Zoological Nomenclature, published in the Smithsonian Misc. Coll., Vol. 73, p. 13, 1926.

Type (by subsequent designation, Children, 1822), *Mya truncata* Linnæus.

Shell of medium average size, elongate trigonal or ovate, rounded anteriorly, somewhat angular and strongly gaping posteriorly; sculpture of concentric growth lines or ridges and very faint radiating irregularities; hinge of left valve with a conspicuous projecting spoon-shaped chondrophore bordered by elevated ridges and often with an additional minor ridge posteriorly; hinge of right valve with a depressed, excavated chondrophore, attached posteriorly to the interior wall of the shell; dorsal margins of both valves conspicuously strengthened, that of the right valve fitting over the left; pallial sinus large, with a blunt rounded end extending horizontally to about the center of the shell.

Geologic range: Eocene to Recent.

Distribution: Cold and temperate waters of all oceans.

Subgenus **MYA**, s. s.

External sculpture of shell very weak.

The typical form of this genus resembles *Schizothærus* in appearance and habits, but the latter has a raised chondrophore in each valve and remnants of Mactroid teeth. Both are mud burrowers, gaining their food through long projecting siphons, and both are typical cold-water groups. *Mya* can stand a considerable amount of brackishness in the water, often living at heads of bays and in estuaries where a large amount of fresh water is being brought in by rivers.

The species of the typical subgenus are all closely related. The two extreme forms, *arenaria* and *truncata*, are quite distinct; but there are a number of intermediate forms that have received various names and are difficult to separate.

Mya arenaria is used considerably in the East for food, and has been studied by the U. S. Fish Commission. One of the Fish Commission papers deals with the development and living conditions.[1]

Mya (Mya) arenaria Linnæus

Mya arenaria Linnæus, Syst. Nat., Ed. 10, p. 670, 1758; W. Wood, General Conch., Vol. 1, p. 91, pl. 17, fig. 3, 1815; Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 356, pl. 6, figs. 3, *a-c*, 1850; S. V. Wood, Mon. Palæo. Soc., Vol. 9, Crag Moll., Vol. 2, p. 279, pl. 28, figs. 2*a-f*, 1857; Gould, Invert. Mass., Binney Ed., p. 55, fig. 375, 1870; Sowerby in Reeve, Conch. Icon., Vol. 20, *Mya*, pl. 1, species 1, 1875; Dall, Bull. 37 U. S. Nat. Mus., p. 70, pl. 49, fig. 9, pl. 55, fig. 2, pl. 69, fig. 2, 1889; Cooper, Calif. St. Mining Bureau, Bull. No. 4, p. 29, 1894; Dall, Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 117, 1904, re-issued by Smithsonian Inst. 1910; Thompson, Rept. B. C. Commissioner of Fisheries for 1912, pp. I-40, I-47, pl. 6, 1913; Dall, in Moffitt, Bull. 533 U. S. Geol. Survey, pp. 46, 47, 1913; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 283, pl. 29, figs. 1*a*, 1*b*, pl. 52, 1918; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 56, pl. 17, figs. 2, 3, 1920; Dall, Bull. 112, U. S. Nat. Mus., p. 53, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 198, pl. 32, figs. 1*a*, 1*b*, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 75, 1929.

Mya hemphilli Newcombe, Proc. Calif. Acad. Sci., Vol. 5, p. 415, 1874; Stearns, American Naturalist, pp. 362-366, 1881; Science, New Series, Vol. 9, pp. 657-58, 1900.

Shell of medium size, elongate, anterior end broadly rounded, posterior margin sloping downward in a broad gentle curve to a more or less rounded or acute point, beaks about in the middle of the shell, or varying somewhat, sometimes considerably to either side.

This species is the normal species of *Mya*. It burrows in the sand or mud and varies considerably in shape according to the nature of the material around it. It also varies into what appear to be distinct races or varieties, the form *truncata* alone having departed sufficiently to be called a different species; and even *truncata* is connected by several intermediate forms. *M. arenaria* varies in the relative depth of the shell, in the position of the beak, in the acuteness of the posterior point, etc. Numerous synonyms have been described besides the one cited above. An interesting variety was described by Sowerby from the British Crag as *Mya lata*.[2] It has a ridge or fold following the normal curve of the posterior dorsal margin; but in addition, it has a wing-like dorsal extension which projects back of the normal posterior point and is abruptly truncated. In other words, it is a variety intermediate between *arenaria* and *truncata*. Another variety, with a more rounded posterior extremity, was described by Dall as *intermedia*; but as the name *intermedia* is preoccupied and an older name seems to be close enough to be applicable, this variety is here recorded as *japonica*. Still another variety, with a shorter, deeper shell was named *crassa* by Grewingk; but as this name is also preoccupied it is here recorded as the variety *profundior*. An unnamed variation represented by a Recent specimen in the Oldroyd Collection at Stanford University from Long Island, New York, has a shell with the typical shape but with about three times the thickness. Toward the limits of the specific distribution all the varieties become much smaller.

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[1] Kellogg, J. L.: "Conditions Governing the Existence and Growth of the Soft Clam (Mya arenaria)," U. S. Commission of Fish and Fisheries, Rept. of Commissioner for 1903, pp. 195-224, pls. 7-10, 1904.

[2] *Mya lata* Sowerby, Min. Conch. Gt. Brit., Vol. 1, p. 185, pl. 81, fig. 1, 1814.

Variety **arenaria**, s. s.

Shell elongate, ovate or acutely pointed posteriorly.

Dimensions: Length, 87 mm.; altitude, 50 mm.; convexity (of two valves), 25 mm. Specimens are known with a length of 135 mm. from the Atlantic.

Type specimen: In London.

Type locality: Northeastern Europe.

? Miocene: Of Unga Island, Alaska (Grewingk; Dall, 1904).[1]

Pliocene: Of Center Creek, Alaska (Dall, 1913); of the Red Crag and later deposits in England (S. V. Wood); uppermost Pliocene of Sicily (S. V. Wood); of Ventura Co., California (Waterfall); of the San Joaquin basin (Cooper, 1894).

Pleistocene: England and continental Europe (S. V. Wood).

Living: Britain, Scandinavia, Greenland, Atlantic Coast of North America south to Carolina, Alaska south to Japan and to Vancouver Island, British Columbia (found in Indian mounds on Vancouver Island, *fide* Oldroyd), artificially introduced about 1865 from the Atlantic Coast with seed oysters into San Francisco Bay whence it has spread along the California and Oregon coasts.

It appears that the typical variety in migrating around through the Arctic changed its form somewhat so that Dall (1904) questioned whether the Pacific coast occurrences could be called typical. Nevertheless, some Japanese specimens are unquestionably the same as those from the Atlantic, and the specimens figured by Grewingk and by Oldroyd seem to be within the limits of variation of the typical form. It is hard to explain why the species did not migrate southward to San Francisco naturally, since it has thrived so well there after artificial introduction. Perhaps the northern race had adapted itself to cold-water conditions so that it could no longer return to the warm; and if so, it should be separated varietally and included perhaps with the next variety. The form introduced into San Francisco Bay received the name *hemphilli.*

Mya (**Mya**) **arenaria** Linnæus variety **japonica** Jay

Plate 21, Figure 13

Mya japonica Jay, in Perry's U. S. Japan Exped., Vol. 2, p. 292, pl. 1, figs. 7, 10, 1857; Arnold, Bull. 396 U. S. Geol. Survey, pp. 42, 43, pl. 29, figs. 7, 8, Jan. 15, 1910, figures reprinted in Bull. 398, pl. 51, figs. 7, 8, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 214, 219, 1917.

Mya intermedia Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 857, 1898; Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Canadian Arctic Exped., Vol. 8, p. 29A, 1919; Bull. 112 U. S. Nat. Mus., p. 52, pl. 4, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 199, pl. 15, fig. 5, 1924; not *Mya intermedia* Sowerby, Min. Conch. Gt. Britain, Vol. 1, p. 173, pl. 76, fig. 1, 1814; Vol. 5, p. 20, pl. 419, fig. 2, 1823, Eocene (?) of Great Britain.

Mya "truncata Linnæus," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 214, pl. 5, fig. 46, 1909, *fide* Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 312, 1922.

? *Mya dickersoni* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 478, pl. 63, figs. 3, 4, 1915; Nomland, Vol. 10, p. 300, 1917.

Shell like that of the typical variety but somewhat shorter, with more rounded extremities; when large, apt to have a coarser, heavier shell.

Dimensions (average of Dall's Alaskan specimens): Length, 115 mm.; altitude, 75 mm.; convexity of two valves, 45 mm. Puget Sound specimens are only about 30 mm. long.

Type specimens: In the U. S. National Museum (?).

Type localities: Of *japonica,* Volcano Bay, Island of Yedo, Japan; of *intermedia,* Alaska.

? Miocene: Unga Island, Alaska (see typical variety); upper Miocene of middle California (Clark, Nomland); "Quillayute Pliocene," Empire formation of Washington (Reagan; Dall, 1922).

Pliocene: St. George Island, Alaska (Dall, 1919); middle and upper Etchegoin, uppermost Pliocene of middle California (Arnold; Nomland).

Pleistocene: Bernard Harbor, Arctic Circle (Dall, 1919); etc.

Living: Arctic Ocean to Japan and to Monterey, California; probably also Atlantic.

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[1] Eichwald has questioned this age. See the note to the variety *profundior.*

This variety is the commonest form of *arenaria* in the northeastern Pacific, and it probably was so in the upper Pliocene when it was very common in the San Joaquin embayment. It is a typically cold water form, growing very large and heavy in Alaska, but diminishing in size southward. Its great abundance in the uppermost Pliocene of the San Joaquin embayment, a few of the specimens reaching a respectable size (the one figured is 70 mm. in length), is very significant, indicative of the colder climate of the time and confirming the correlation of the *Mya japonica* zone with the cold Santa Barbara zone along the open coast.

The form *japonica* is distinguished from typical *arenaria* by its somewhat shorter, coarser, rougher shell. It is intermediate between *arenaria* and *truncata*. Jay, Dall, and Clark all stress differences in the chondrophore. Jay says "the tooth more thickened," . . . "its outer face divided near the posterior side by a deep furrow, and the anterior edge turned up in shape like a tooth." Dall says "there are constant though not conspicuous differences in the hinge". Clark states "that the posterior ridge on the chondrophore extends out beyond the edge." The present writers find that the character of the chondrophore varies somewhat, and that in this respect the form *japonica* of Jay, the Etchegoin specimens of Arnold, and *dickersoni* of Clark agree better with the typical *arenaria* than does Dall's *intermedia*. However, there are some Etchegoin specimens on which the posterior ridge of the chondrophore does not project and the furrow is not deep; and there are some living specimens with the *intermedia* shape that have a projecting posterior ridge separated by a furrow. In other words, there is a criss-cross combination of the characters of shell shape and chondrophore ridge, so that one or the other or both must be considered unreliable. Similarly, the size and shape of the pallial sinus vary without respect to the other shell characters. In view of the slight differences between *arenaria* and *japonica*, the difficulty of telling them apart, the wide and practically coincident distribution of the two forms (although *arenaria* is said to live in shallower water, *japonica* being intermediate in this respect also between *arenaria* and *truncata*), and in view of the fact that the characters are very variable and intergrade and appear in different combinations, it seems advisable to treat the two forms as no more than ecologic or geographic varieties of the same species. Some of the living forms of *arenaria* along the coasts of Washington and British Columbia have the characters of typical *arenaria;* and if it be stated that they are representatives of the Atlantic coast form migrating northward from San Francisco, it can be answered that if so, they have in this short time come to look so much like their native brothers that in the course of a geologic age they would become indistinguishable, thus showing the nature of their differences to be like those of geographic varieties, not yet great enough to make them separate species.

The chondrophores of all the varieties of *arenaria* differ from those of *truncata* in being more spoon-shaped, more rounded at the end, whereas those of *truncata* are shorter, somewhat trigonal, cut off with but a gentle curve at the end, and the posterior ridge never projects and is not separated from the chondrophore by a deep furrow. *M. truncata* is also distinguished by its less sloping dorsal margins, which extend almost straight posteriorly and then turn abruptly at the broad, bluntly rounded, squarely truncated, or even concave posterior extremity. The young, however, are difficult to distinguish, both being rounded and elongate.

The young are also difficult to distinguish from *Cryptomya,* the differences being that the young typical Myas are somewhat more elongate and that on Recent material the pallial sinus can be seen even on very small individuals.

Mya (Mya) arenaria Linnæus variety **profundior,** new name

Mya crassa Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 355, pl. 6, figs. 2*a-d*, 1850; Dall, Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 117, 1904, reissued by Smithsonian Inst., 1910; not *Mya crassa* Vallot, Exer. Hist. Nat., p. 7, 1801; nor *Mya crassa* Wood, General Conchology, p. 106, pls. 20, 21, 1815, a *Unio.*

Shell like that of the typical variety but relatively much shorter and deeper.

Dimensions: Length, 83 mm.; altitude, 103 mm.; convexity of the two valves, 53 mm.

Type specimen: At Leningrad (?).

Type locality: Probably on the southeast coast of the Peninsula of Alaska near the settlement at Pavloff, where Grewingk says it is common. Horizon Miocene according to Dall.[1]

Miocene: Of various places in Alaska, the type locality, also at Morshovsky Bay, Möller Bay, and on Kadjak and Unga islands (Grewingk; Dall).

This may be but an unusual variation of the form for which Dall used the preoccupied name *intermedia;* and if it is decided to separate the latter from *japonica* and *dickersoni,* it may be possible to use this name for it. These varieties are all very closely related, Dall stating in 1904 that this very deep, heavy form intergrades with the elongate form called by Grewingk *arenaria;* and yet it is much closer to Dall's own form *intermedia.* It is characterized by its extreme depth, having a greater depth than length, as can be seen by the dimensions which are the reverse of those of the other varieties. Grewingk had several specimens with these proportions. The hinge appears to be like that of Dall's *intermedia.* The posterior dorsal margin slopes off abruptly, not at all like that of *truncata.*

Mya (Mya) truncata Linnæus

Mya truncata Linnæus, Syst. Nat., Ed. 10, p. 670, 1758; W. Wood, General Conchology, Vol. 1, p. 90, pl. 17, figs. 1, 2, 1815; Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 356, 1850; S. V. Wood, Mon. Palæo. Soc., Vol. 9, Crag Moll., Vol. 2, p. 277, pl. 28, figs. 1*a-f*, 1857; Gould, Invert. Mass., Binney Ed., p. 58, fig. 376, 1870; Sowerby in Reeve, Conch. Icon., Vol. 20, *Mya*, pl. 1, species 4, 1875; Dall, Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, pp. 117, 121, 1904, reissued by the Smithsonian Inst., 1910; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 545, pl. 50, fig. 1, 1907, figure reproduced in Bull. 309, U. S. Geol. Survey, pl. 40, fig. 1, 1907; Dall, Prof. Paper 59 U. S. Geol. Survey, p. 132, 1909; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, pp. 590, 596, 598, 1913; Dall in Moffit, Bull. 533 U. S. Geol. Survey, p. 46, 1913; Baker, Bull. Amer. Mus. Nat. Hist., Vol. 41, p. 499, 1919; Dall, Canadian Arctic Exped., Vol. 8, p. 29A, 1919; Bull. 112 U. S. Nat. Mus., p. 52, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 197, pl. 10, fig. 4, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Mya præcisa Gould, Proc. Bost. Soc. Nat. Hist., Vol. 3, p. 215, 1850; U. S. Exploring Exped. (Wilkes), Vol. 12, p. 385, 1852, Mollusca Atlas, pl. 33, figs. 498, *a*, *b*, 1856; Sowerby, in Reeve, Conch. Icon., Vol. 20, *Mya*, pl. 2, species 7, 1875; Dall, U. S. Geol. Survey, 17th Ann. Rept., p. 845, 1896.

Mya "japonica Jay," Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 252, 1916 (*fide* Howe).

Shell of medium size, elongate, dorsal margins extending nearly in a straight line parallel to the ventral margin, the beaks rising somewhat above them, anterior end broadly rounded, posterior end somewhat narrower and longer, with a bluntly rounded, squarely truncated, or even concave extremity; sculpture of irregularly undulating growth lines; chondrophore of left valve shorter, broader, shallower, and with more angulated corners than that of *arenaria*, the posterior ridge separated from the main hollow of the chondrophore by a shallow furrow and smaller ridge, but not so clearly so as in *arenaria*, not extending beyond the edge of the chondrophore, the rest of the interior as in *arenaria;* pallial sinus very variable.

Dimensions: Length, 65 mm.; altitude, 45 mm.; convexity of the two valves, 30 mm.

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[1] While this was in galley proof, the writers found at the California Institute of Technology a photostat copy of an article by Eduard von Eichwald entitled "Die Miocän- und Kreideformation von Alaska und den Aleutischen Inseln," from the K. Akademie d. Wissenschaften, St. Petersburg, 1871. In this paper Eichwald attributes all of Grewingk's Miocene mollusks to the Turonian Cretaceous, mentioning *crassa* on p. 124, and renaming Grewingk's *Mya arenaria* on p. 119 *Anatina elegans.* Perhaps the name *elegans* could be used instead of *profundior.* Eichwald found a considerable number of Ammonites, but it seems hardly possible that he could have found Grewingk's pelecypods in the same beds. Compare the note to *Nucula ermanni*, p. 117.

Type specimen: In London (?).

Type locality: Europe.

Miocene: Near the settlement at Pavloff in the Peninsula of Alaska (Grewingk; Dall, 1904); Empire formation of Oregon (Dall, 1909; Arnold and Hannibal; Howe).

Pliocene: Coralline and Red Crags, England (S. V. Wood); Alaska (Dall); Elsmere Canyon, Los Angeles Co., California (Arnold); lower Etchegoin of the Federal Exploration Co. well Kinsella No. 1, Tulare Co., Calif., one hinge plate (H. R. G.); Wildcat formation of northern California (Martin); upper Pico of Ventura Co. (Waterfall).

Pleistocene: Of boreal regions generally (Dall).

Living: Circumboreal, in the Atlantic south to Great Britain and Massachusetts, in the Pacific south to Puget Sound.

This species is usually smaller and more irregular than *arenaria*, and can be distinguished by its truncated posterior end and its differently shaped chondrophore. It inhabits deeper water than *arenaria*. As in Great Britain, it occurs in California lower in the Pliocene section, indicating perhaps that it could go farther south in deeper water when the temperature was warmer.

There is a curious short form of this species with a deformed appearance that has had an unusually wide distribution for such a form. It was originally found fossil at Uddevalla, southern Norway, and was called *uddevallensis*.[1] Later it was found in the Clyde beds of England, and Lyell found and illustrated the same peculiar form from the Pleistocene along the Gulf of St. Lawrence, stating that it is still living in that region. It was to Lyell's illustration that Grewingk referred when he reported *truncata* from the Tertiary of Alaska and to which he compared *M. crassa*. However, the typical form is also known to occur in the Tertiary of Alaska, and Middendorff figures the typical form living.

Subgenus **PLATYODON** Conrad, 1837

Platyodon, Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 235, 1837; Dall, Trans. Wagner Free Inst. Sci., Vol. 3, pp. 858, 885, 1898.

Type (by monotypy), *Mya* (*Platyodon*) *cancellata* Conrad, living, California.

Shell like that of the typical subgenus but with a smaller chondrophore, and sculptured with concentric ridges formed by emphasizing the growth lines; animal with armor on the end of the siphons as in *Mya truncata*.

Until recently but one species has been known in this subgenus, but a larger, deeper form has just been discovered by Mr. Wiedey in the lower Miocene of San Luis Obispo County. The writers regard the minor differences in the sculpture and in the size of the chondrophore between *Platyodon* and the typical subgenus as not more than subgeneric in significance. Here as elsewhere the tendency is to subdivide genera until they no longer mean anything and are of no use in making identifications.

Mya (Platyodon) cancellata Conrad

Plate 24, Figures *3a, 3b*

Mya (*Platyodon*) *cancellata* Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, p. 236, pl. 18, fig. 2, 1837; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 285, pl. 29, figs. *2a, 2b*, 1918.

Mya cancellata Conrad, Sowerby in Reeve, Conch. Icon., Vol. 20, *Mya*, pl. 2, species 8, 1875.

Platyodon cancellatus Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 637, 1864, reprinted Smithsonian Misc. Coll., No. 252, p. 123, 1872; Tryon, Struct. and Syst. Conch., Vol. 3, pl. 106, fig. 28, 1884; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 260, 1888; Keep, West Coast Shells, p. 208, fig. 177, 1888, 1892; Arnold

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[1] *Mya truncata* variety *uddevallensis* Smith, see S. V. Wood, *loc. cit.*, fig. 1*c*; Lyell, Trans. Geol. Soc. London, Ser. 2, Vol. 6, p. 137, pl. 16, figs. 5, 6, 1842.

Mem. Calif. Acad. Sci., Vol. 3, p. 179, 1903; Keep, West Amer. Shells, p. 90, fig. 80, 1904; p. 100, fig. 78, 1911; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 62, pl. 17, fig. 1, 1920; Dall, Bull. 112 U. S. Nat. Mus., p. 53, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 202, pl. 32, figs. 2*a*, 2*b*, 1924.

Mya (*Platyodon*) *cancellatus* Conrad, Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 419, pl. 64, fig. 1, 1915; Nomland, Vol. 10, p. 300, 1917.

Shell of medium size, heavy, elongate, strongly convex, rounded anteriorly, beaks varying in position from the middle to the posterior third of the shell, dorsal margins sloping about as in *Mya arenaria*, posterior end narrow, sometimes short, truncated; sculpture of lamelliform growth lines, averaging altogether about 80, and faint irregular radial lines, very fine and numerous; chondrophore of left valve small, narrow, bounded by strong ridges, especially the posterior, that of the right valve small, short, hidden under the umbo, guarded on the posterior dorsal margin by a tooth-like porjection; umbones strongly incurved, the beaks worn away by rubbing against the opposite valve; pallial sinus very variable, usually reaching about to the middle of the shell.

Dimensions: Length, 67 mm.; altitude, 40 mm.; convexity of the two valves, 37 mm.

Type specimen: At the Academy of Natural Sciences, Philadelphia (?).

Type locality: Near Santa Barbara, California.

Miocene: Santa Margarita-San Pablo of middle California (Clark; Nomland).

Pleistocene: Upper San Pedro series of Deadman Island, San Pedro, and vicinity, Los Angeles Co. (Arnold); localities 40 and 74 S. D. S. N. H., near Goleta, Santa Barbara Co., eight specimens (U. S. G.).

Living: Baulinas Bay, middle California, to San Diego (Dall).

This species is distinguished from the other species of *Mya* by its concentric sculpture, elongate, heavy, strongly convex shell, and smaller chondrophore. It is a little more southerly in range.

Genus CRYPTOMYA Conrad, 1848

Cryptomya Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 4, p. 121, Dec., 1848; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 859, 1898.

Type (by monotypy), *Sphænia californica* Conrad, Miocene to Recent, California.

Like a small *Mya* but without the long protruding siphons and consequently with but a slight posterior gape and the pallial sinus obsolete or very short; shell small, ovate, not very convex; chondrophore similar to that of *Mya arenaria;* interior of dorsal margins thickened.

Geologic range: Miocene to Recent.

Distribution: Gulf of California to Japan.

Various names have been proposed for forms of *Cryptomya* with slightly different shapes, but a study of the variations shown by series of specimens from single localities has led the writers to believe that there is but one widely distributed variable species in the eastern Pacific.

Dr. Clark of the University of California and Dr. Hanna of the California Academy of Sciences have considered *Cryptomya* a subgenus of *Mya*. It is true that the two are closely related, and that with fossil specimens on which the pallial sinus is not visible it is sometimes impossible to tell a *Cryptomya* from a young *Mya* or one of the small Myas that occur sometimes abundantly, near the limits of the distribution of their species. However, the lack of the long siphons, which indicates apparently some difference in the living habits, may be of sufficient significance to warrant the separation of a distinct genus. It is only a matter of degree, and neither view can be wrong.

Cryptomya californica (Conrad)

Plate 21, Figures 7, *8a*, *8b*, 11, *14a*, *14b*

Sphænia californica Conrad, Journ. Acad. Nat. Sci., Phila., Vol. 7, p. 234, pl. 17, fig. 11, 1837; Carpenter, Proc. Zool. Soc. London, p. 210, 1856.

Cryptomya californica Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 4, p. 121, Dec., 1848; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 637, 1864, reprinted in Smithsonian Misc. Coll., No. 252, 1872; Gabb, Geol. Survey, Calif., Palæo., Vol. 2, p. 90, 1868-69; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 237, 1888; Keep, West Coast Shells, p. 205, 1888, 1892; Newcombe, Nat. Hist. Soc. Brit. Columbia, p. 43, 1893; Arnold, Mem., Calif. Acad. Sci., Vol. 3, p. 180, 1903; Keep, West Amer. Shells, p. 89, 1904; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 526, 1907; Eldridge and Arnold, Bull. 309 U. S. Geol. Survey, pp. 25, 26, 27, 153, 1907; Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 202, 1916; Martin, pp. 243, 251, 1916; Nomland, Vol. 10, p. 218, 1917; Dall, Nautilus, Vol. 32, p. 24, 1918; Bull. 112 U. S. Nat. Mus., p. 53, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, pp. 550, 563, 1922; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 199, 1924; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Cryptomya ovalis Conrad, Proc. Acad. Nat. Sci., Phila., Vol. 8, for Dec., 1856, p. 314, 1857; U. S. Pacific R. R. Surveys, Vol. 6, p. 69, pl. 2, fig. 2, 1857, reprinted by Dall, U. S. Geol. Survey, Prof. Paper 59, pp. 174, 176, 1909; Arnold and Anderson, Bull. 322, U. S. Geol. Survey, p. 58, pl. 22, fig. 7, 1907; Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 4, pl. 55, fig. 7, 1907; Proc. U. S. Nat. Mus., Vol. 34, pp. 353, 354, pl. 36, fig. 9, 1908; Bull. 396 U. S. Geol. Survey, pp. 21, 24, 25, 27, 30, 34, 38, pl. 22, fig. 5, Jan. 15, 1910, reprinted in Bull. 398, pl. 44, fig. 5, 1910; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Nomland, Vol. 9, p. 81, 1916; Martin, pp. 239, 243, 251, 1916; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922.

Mya californica Conrad, Sowerby in Reeve, Conch. Icon., Vol. 20, *Mya*, pl. 1, species 3, 1875.

Cryptomya oregonensis Dall, Prof. Paper 59 U. S. Geol. Survey, p. 132, pl. 11, fig. 4, 1909; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 596, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916.

Cryptomya quadrata Arnold, Bull. 396 U. S. Geol. Survey, p. 71, pl. 21, figs. 2, *2a*, Jan. 15, 1910, figures reprinted in Bull. 398, pl. 43, figs. 2, *2a*, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 9, pp. 81, 202, 1916; Martin, pp. 245, 252, 1916; Nomland, Vol. 10, pp. 211, 218, 1917.

Cryptomya washingtoniana Weaver, Bull. No. 15 Wash. Geol. Survey, p. 70, pl. 13, fig. 114, 1912.

Mya (*Cryptomya*) *ovalis* Conrad, Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 479, pl. 60, figs. 3, 4, 1915; Nomland, Vol. 10, p. 300, 1917.

Cryptomya washingtonensis Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916.

Mya (*Cryptomya*) *californica* (Conrad), Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 284, pl. 31, figs. *2a*, *2b*, pl. 53, 1918.

Cryptomya magna Dall, West Amer. Scientist, Vol. 19, No. 2, p. 17, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 15, pl. 13, figs. 3, 4, 1925.

Mya inopia Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 172, 1924, unnecessary new name for *C. ovalis*.

Macoma kerica Hendrickson, Ann. Rept. Calif. St. Oil and Gas Supervisor (Summary of Operations, California Oil Fields), Vol. 13, No. 7, pp. 13, 15, 16, 18, pl. 5, fig. 1, Jan., 1928.

Shell rather small, not very convex, ovate, anterior end smoothly rounded, beaks not very prominent, varying somewhat in position, sometimes anterior, sometimes posterior to the middle, dorsal margins broadly rounded, beaks at the starting point of two, more abruptly sloping ridges, the posterior ridge more distinct and separated from the dorsal margin by a sulcus, posterior end bluntly truncated, with this sulcus meeting it about in the middle, practically no posterior gape, ventral margin gently curving; sculpture of fine growth lines, and, especially on small specimens, faint radiating lines; chondrophore of left valve similar to that of *Mya arenaria* but somewhat shorter and broader, bordered by two strong ridges, the posterior separated by a fainter ridge and sulcus from the main bowl of the chondrophore, sometimes projecting like a tooth; dorsal margins of both valves strongly reinforced; the chondrophore of the right valve a weak partition joined to the interior of the shell by its upper and posterior sides and hidden under the beak in a broad hollow excavated in the thickened dorsal margin, the right valve fitting over the left; pallial sinus very short and inconspicuous, not passing beyond the posterior muscle scar.

Dimensions: Length, 30 mm.; altitude, 20 mm.; convexity of two valves, 11 mm.

Type specimens: Of *californica* and *ovalis*, at the Academy of Natural Sciences, Philadelphia (?); of *oregonensis*, No. 153,931; of *quadrata*, No. 165,525; of *magna*, No. 333,127, in the U. S. National Museum; of *washingtoniana*, at the University of Washington; of *kerica*, at the California Academy of Sciences.

Type localities: Of *californica*, living near Santa Barbara; of *ovalis*, Monterey Co., probably Miocene; of *oregonensis*, Empire formation, upper Miocene, of Coos Bay, Oregon; of *quadrata*, Etchegoin formation, Pliocene of the Coalinga district, middle California; of *washingtoniana*, Montesano formation, upper Miocene of Washington; of *magna*, Pleistocene of San Quintin Bay, Lower California; of *kerica*, basal marine Pliocene, *Cryptomya californica* zone, of well cores in the southeastern end of the San Joaquin basin, California.

U. Miocene: Montesano formation of Washington (Weaver); Empire formation of Oregon (Dall, 1909; Howe); Santa Margarita-San Pablo of California (Clark; Nomland, 1917).

Pliocene: In practically every Pliocene region and horizon reported on in California, especially abundant in the basal marine Pliocene of the southeastern end of the San Joaquin basin.

Pleistocene: Elk River beds, Oregon (Arnold and Hannibal); in practically every California locality, especially in the base of the Las Posas zone of the Ventura district; San Quintin Bay, Lower California (Dall, 1925; Jordan); Magdalena Bay (Dall, 1918).

Living: Alaska to Topolobampo, Mexico (Dall, 1921*a*), probably also Japan.

Before working with this common species, it is well to examine several series of specimens from different localities, living and fossil, to see the variation. It will be seen that nearly all the shapes upon which the named forms are based are represented in each series of variations, but that in some collections the specimens are all or nearly all smaller than in others. This difference in size may be accounted for by differences in the suitability of the environments. The state of preservation has a great deal to do with the differences in the appearance of the fossil specimens.

The name *Mya inopia* is unnecessary because there are several other names available for this species, even in case it were agreed that *C. ovalis*, originally so named, is preoccupied by *Mya ovalis* of several earlier authors when none of their species is now assigned to *Cryptomya*. If an attempt is made to separate the Miocene from the Recent form, the name *oregonensis* should be used for the former; and there are several more names for Pliocene forms, though it is inconvenient to have to identify the horizon before the species can be determined.

The type of "*Macoma*" *kerica* is so poor that nothing can be learned by looking at it except that it is a small ovate pelecypod. However, it occurs abundantly, according to the description, in a zone associated with oil-bearing beds in the lower part of the marine Pliocene of the southeastern part of the San Joaquin basin, accompanied by characteristic "pebbles" of a gray color with a black surface coating. This same zone was recognized in the Fruitvale district, where *Cryptomya californica* is very abundant and *Macoma* is comparatively scarce. The "pebbles" appear to be nodules with the organic impurities concentrated on the surface. They break down readily in acid.

Specimens from Japan in the Oldroyd Collection at Stanford University labelled *C. elliptica* Adams are identical with the smaller specimens of *C. californica*. As the original of *C. elliptica*[1] was said to come from Australia, and as the specimen figured by Sowerby shows a deep pallial sinus, the true *elliptica* is probably something else. Whether *Mya mindoroensis* Adams and Reeve, or *C. truncata* Gould, or some other name is the one now used for the Japanese *Cryptomya*, probably one or more of these western Pacific names should be added to the synonymy of *californica*.

Conrad's *Mya montereyana* and *Mya subsinuata*, described and figured in the same places as *C. ovalis*, might also be synonyms, but it is impossible to tell what they are.

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[1] *Sphænia elliptica* A. Adams, Proc. Zool. Soc. London, p. 88, 1850. ? *Mya elliptica* A. Adams, Sowerby in Reeve, Conch. Icon., Vol. 20, *Mya*, pl. 1, species 2, 1875.

The former has a *Mya-Cryptomya* hinge and is rather small (1¼ inches long); the latter has the shape of Conrad's *Sanguinolaria nuttallii*, and does not show the hinge.

It is quite likely that *C. californica* is a direct descendant of *Mya arenaria* (or *vice versa*), for the two have many details of character in common that can hardly be all coincidences. The differences between them are all explainable as the effects of their having assumed different habits, the smaller shell having decided, probably some time during the Miocene, no longer to keep its siphons habitually extended. This relationship is a strong argument for including *Cryptomya* in the genus *Mya*.

Genus SPHENIA Turton, 1822

Sphenia Turton, Conchylia Insularum Britannicarum, or The Shells of the British Isles, p. 36, 1822, species included are *binghami* Turton, *swainsoni* Turton, and *Mya decussata* Montagu; Gray, Proc. Zool. Soc. London, p. 190, 1847, type cited *S. binghami;* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 359, 1898.

"*Sphæna* Turton;" "*Sphænia* Turton," of various authors.

Type (by subsequent designation, Gray, 1847), *Sphenia binghami* Turton, *op. cit.*, p. 36, pl. 3, figs. 3, 4, pl. 19, fig. 3, 1822, living Torbay, England.

Shell like that of a small *Mya*, very small, thin, irregular in shape, the chondrophore small, thin, oblique, practically characterless.

Geologic range: Miocene ? to Recent.

Distribution: Cold and temperate waters of the Atlantic and Pacific.

This genus, as Dall points out, is barely separable from *Mya*. It is a small degenerate offshoot, with the nestling habit. Dall says that it has a deep pallial sinus, but the type specimen of Dall's *Sphenia glabata* in the Oldroyd Collection at Stanford University appears to have a sinus like that of *Cryptomya*. The interiors of the other species in the collection are not visible, or do not show the sinus. The posterior extremity is usually somewhat narrowed and drawn out, with a small gape. Specimens of this genus are distinguishable from small specimens of *Saxicava* by their chondrophore.

There are one or more Pacific coast living species listed by Dall in Bulletin 112 of the U. S. National Museum (p. 53), probably with too many names. Gabb described a species from the "Miocene of Santa Barbara," but it was never figured, and it may not be a *Sphenia*.[1]

Family CORBULIDAE

Shell small, thick, inequivalve, with a small posterior gape; sculpture sometimes discrepant; hinge generally with one stout cardinal tooth in the right valve and a smaller, nearly obsolete tooth in the left valve, each fitting into a fosset in the opposing valve; ligament subexternal, resilium internal; pallial sinus nearly obsolete.

Genus CORBULA Bruguière, 1797

Corbula Bruguière, Encycl. Méth., pl. 230, 1797, species figured but none named; Lamarck, Mém. Soc. Hist. Nat., Paris, p. 89, 1799, no species named; Syst. Anim. s. Vert., p. 137, 1801, several named species assigned to genus; Children, Quart. Journ. Sci., Lit., Arts, p. 301, January, 1823, *Corbula nucleus* Lamarck designated as type; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 836, 837, 1898; Gardner, Nautilus, Vol. 40, pp. 41-45, 1926.

"*Agina* Turton," of some authors, not of Turton, Conchyl. Insul. Britan., *Dithyra*, p. 54, 1822, which = *Saxicava*.

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[1] *Sphænia bilirata* Gabb, Proc. Acad. Nat. Sci., Phila., Vol. 13, p. 369, 1862.

Type (by subsequent designation, Children, 1823),[1] *Corbula nucleus* Lamarck, = *Corbula gibba* (Olivi), Zool. Adriatica, p. 101, 1792, Mediterranean Sea and west coast of Europe; Recent, also fossil.[2] Figured by Reeve, Conch. Icon., Vol. 2, *Corbula*, pl. 2, fig. 10*a*, 10*b*, 1843.

Subgenus **CORBULA**, s. s.

Shell generally small, subtrigonal; valves unequal, the right valve larger, obtusely rostrate posteriorly; umbones prosogyrous or erect, curved over; sculpture discrepant, the right valve with definite concentric ribs, the left with faint, widely spaced radials and sometimes indistinct growth striæ; posterior end with a small gape; hinge of the right valve with a single stout cardinal tooth behind which is a large pit, hinge of the left valve with a protruding process in front of a pit, into which the cardinal of the right valve fits; laterals absent; ligament chiefly internal; pallial sinus very small.

The subgenus *Corbula, sensu stricto*, includes "*Aloidis* Mühlfeldt" of Gray, Fischer, Cossmann, Bucquoy, Dautzenberg, and Dollfus, Woodring, and others, but not the true *Aloidis, sensu stricto*, of Megerle von Mühlfeldt.[3] The typical subgenus occurs as early as the Eocene in the region bordering the Gulf of Mexico and is represented in the Pliocene of California by *Corbula binominata* Hanna, and by a new species described below.

Corbula (Corbula) gibbiformis, new species

Plate 19, Figures 4, 5, 6

? *Corbula*, n. sp., Merriam in Watts, Bull. 19, Calif. State Mining Bureau, p. 221, 1900.

Shell of medium size, trigonal, plump; right valve strongly ventricose, with strong, concentric, closely-spaced riblets, left valve smaller, more elongate, with about five low, narrow, sharp radial riblets; right hinge with one strong cardinal tooth beneath the curved-over umbo and anterior to a prominent pit; left valve with a pit and a low, tooth-like prominence posterior to it. Length, about 13 mm.; height, about 13 mm.

Type specimens: Holotype No. 172, S. D. S. N. H.; paratypes Nos. 171 and 173 S. D. S. N. H., type collection.

Type locality: Southern California Gas Company's well No. 1-4, Sec. 4, T. 28 S., R. 23 E., Kern County, depth 3951-2 feet, upper Etchegoin formation, upper Pliocene.

> *Pliocene:* At the type locality, upper Etchegoin; also collected by Alex. Clark in the *Pecten coalingensis* zone of the Kettleman Hills, Coalinga district, middle California, and at loc. 442 S. D. S. N. H., middle Pliocene of the Santa Clara Valley; ? near Camulos, Ventura Co. (Watts).

This species has very much stronger concentric sculpture on the right valve than *Corbula binominata* Hanna. The latter species was described from poor material from the Pliocene fossil bed at Fourth Street and Broadway, Los Angeles. *C. gibbiformis* is very similar to *C. gibba* (Olivi) of the Adriatic Sea, but the California species has much coarser concentric ribs and is less elongate; otherwise the resemblance is striking.

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[1] Stewart (Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 286, 1930) accepts Schmidt's designation (Vers. Einr. Conch.-Samml., pp. 57, 77, 177, 1818) of *Corbula sulcata* Lamarck, a Recent species from Senegal, figured by Bruguière on pl. 230, figs. 1*a*, 1*b*, 1*c*, and by Reeve, Conch. Icon., Vol. 2, *Corbula*, pl. 1, sp. 2, 1843. Schmidt's designation is unfortunate, as it leaves the application of *Corbula, s. s.*, uncertain; but perhaps it may be disregarded, for on p. 57 he designated three species as types. If *sulcata* is accepted as type, *Aloidis* becomes an exact synonym (*fide* Gardner). *C. sulcata* has the same shape as *gibba* (which is also shown on Bruguière's plate, figs. 4*a*, 4*b*), and the two species were retained in the same group by Bucquoy, Dautzenberg, and Dollfus; but *sulcata* appears to have well-developed concentric sculpture on both valves and is probably somewhat more closely related to *Lentidium* than is *gibba*. Gardner suggests that *Cæstocorbula* Vincent (Ann. Soc. Roy. Zool. Malac., Vol. 44, p. 141, 1910), of which she says the type is *C. henckeliusi* Nyst, might be applicable to the *gibba* group. However, *C. henckeliusiana* Nyst (described in "Rech. Coq. Foss. Housselt," Mess. Sci. Arts Belg., Vol. 4, p. 144, 1836, *fide* Sherborn, and referred to by Bronn as Nyst, p. 63, pl. 1, fig. 3) is said by Bronn (Index Palæontologicus, Vol. 1, p. 335, 1850) to resemble *cuspidata* Sowerby. Bronn gives the age of *henckeliusiana* as Eocene and that of *cuspidata* as Miocene. The latter (Min. Conch. Gt. Brit., Vol. 4, p. 85, pl. 362, figs. 4, 5, 6, 1822) comes from the upper marine formation in Colwell and Whitecliff Bays on the Isle of Wight. Its valves are about equally sculptured with fine concentric lines, and it looks more like *luteola* than *gibba*. In case a new name is needed for the *gibba* group, we propose *Varicorbula*, with *Corbula gibba* (Olivi) as figured by Bucquoy, Dautzenberg, and Dollfus for the type.

[2] Bucquoy, Dautzenberg, and Dollfus (Moll. Mar. Roussillon, Vol. 2, pp. 578-585, pl. 85, figs. 1-6, varieties figs. 7-23, 1896) have given a good discussion of this species and a long list of references.

[3] *Fide* Gardner, Nautilus, Vol. 40, p. 43, 1926. Von Mühlfeldt's paper is not in any California library.

Corbula (Corbula) binominata Hanna

Corbula tenuis Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 59, pl. 2, figs. 4*a*, 4*b*, 1916; not *Corbula tenuis* Sowerby, Proc. Zool. Soc. London for 1833, p. 36.

Corbula binominata Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 163, 1924, new name.

Type specimen: In the University of California collection, No. 11,087.

Type locality: Fourth Street and Broadway, Los Angeles; upper Pliocene.

Pliocene: Excavation at corner of Fourth Street and Broadway, Los Angeles (Moody).

There is some question about which valve Moody figured in his original description of this species. On the explanation to the plate his figure 4*b* is stated to be the left valve, but in the text he remarked that the "left valve is unknown." This figure shows faint concentric sculpture and no radial riblets. If it is a right valve the umbo is less broadly inflated and the sculpture much less prominent than that of *C. gibbiformis.*

Subgenus **LENTIDIUM** Cristofori and Jan, 1832

Lentidium Cristofori and Jan, Catal., Sect. 2, p. 8, 1832; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 581, 1847; Gray, Proc. Zool. Soc. London for 1847, p. 191, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 838, 1898.

Corbulomya Nyst, Mém. Cour., Acad. Roy. Sci. Brussels, Vol. 17, p. 59, 1845; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 308, 1847; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 585, 1896.

Type (by subsequent designation, Dall,[1] 1898), *Lentidium maculatum* Cristofori and Jan, = *Corbula mediterranea* (Costa), Catal. Test. Sicil., pp. xiv, xxvi, 1829, *fide* Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 30, 1884; figured by Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 585, pl. 85, figs. 24-29, 1896; Mediterranean Sea; Recent.

Shell nearly equivalve, elongate trapezoidal, with concentric sculpture on both valves, often rather feeble; ligament sometimes visible externally in a fissure near the umbo.

Corbula (Lentidium) luteola Carpenter

Plate 19, Figures 2, 7

Corbula luteola Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 637, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 236, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 181, pl. 17, fig. 11, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 53, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 203, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 154, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Corbula luteola var. *rosea* Williamson, Bull. So. Calif. Acad. Sci., Vol. 4, p. 120, 1905; not *Corbula rosea* Leach in Brown, 1844.

Shell small, elongate, thick, nearly equivalve, left valve slightly smaller; beaks subcentral, slightly posterior; anterior end evenly rounded, posterior end somewhat bluntly truncated, a blunt ridge extending from near umbo to posterior ventral margin; sculpture on both valves of fine concentric ridges; right valve with a prominent cardinal tooth in front of resilial pit, left valve with a small cardinal projection; pallial sinus very small, nearly absent; adductor impressions relatively large, distinct from pedal scar. Size variable; length, 9.5 mm.; height, 6.5 mm.; convexity of matched valves, 4 mm.

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[1] Both Herrmannsen and Gray cited *Corbula mediterranea* as the generic type. The present authors have been unable to see Cristofori and Jan's Catalogus, but as it seems unlikely that those authors mentioned *Corbula mediterranea*, the type designation has been given as of Dall. The uncertainty does not affect the subgenus.

Type locality: Between San Diego and San Pedro; Recent..

Upper Miocene: Well cores near Bakersfield (H. R. G.).

Pleistocene: "Pliocene" of Deadman Island; lower San Pedro series at Deadman Island and San Pedro; upper San Pedro series at San Pedro and Los Cerritos [Los Cerritos = ? lower Pleistocene]; foot of Twenty-sixth Street, San Diego (Arnold); low terrace near beach at Seacliff station, about eight miles northwest of Ventura (Stanford collection); Santa Monica palisades (coll. by E. C. Clark); upper Pleistocene at San Ignacio Lagoon and at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926).

Recent: Monterey, California, to Acapulco, Mexico (Jordan, 1924).

This is the common *Corbula* of the southern California coast. The variety *rosea* Williamson has no significance whatsoever. Pinkish or rosy-colored individuals occur indiscriminately associated with the yellowish form. The name *rosea* was used for a *Corbula*[1] many years before Williamson used it.

Corbula (Lentidium) fragilis Hinds

Corbula fragilis Hinds, Proc. Zool. Soc. London for 1843, p. 56, Nov., 1843; Reeve, Conch. Icon., Vol. 2, *Corbula*, pl. 3, fig. 19, January, 1844; Hinds, Zool. Voy. Sulphur, Moll., p. 68, pl. 20, fig. 11, 1845; Dall, U. S. Nat. Mus., Bull. 112, p. 53, 1921; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, pp. 560, 563, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 203, 1924.

Type locality: West coast of Veragua, Mexico, found in mud at a depth of eighteen fathoms (Hinds).

Pleistocene: Tomales Bay, Marin County, California (Dickerson).

Recent: Monterey, California, to Salina Cruz, Mexico (Dall).

This species, as figured by Reeve, is more narrowly produced posteriorly than *Corbula luteola* Carpenter, has more prominent concentric sculpture, and averages a little larger. A Recent specimen in the Oldroyd collection from west Mexico is not so narrowly produced posteriorly and has less elevated umbones than the specimen figured by Reeve. It looks much like *luteola* except that it is larger, thinner shelled, and has more prominent concentric sculpture. *C. luteo'a* may be a less vigorous northern variety.

Dickerson reported *Corbula fragilis* abundant in a clay bed of the Millerton formation near Tomales Bay, Marin County, north of San Francisco.

Corbula (Lentidium) porcella Dall

Corbula porcella Dall, Proc. U. S. Nat. Mus., Vol. 52, p. 415, 1916; U. S. Nat. Mus., Bull. 112, p. 54, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 204, 1924; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Type specimen: In the U. S. National Museum, No. 97,039.

Type locality: Off Lower California, Mexico; in 44 fathoms, mud bottom.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Type locality.

This name was applied to an unfigured shell dredged off Lower California. No comparison was given with the other species of the region, and the name is likely to be a synonym of some older one.

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[1] *Corbula rosea* (Leach MSS.) Brown, Illustr. Conch. Gt. Brit., Ed. 2, p. 105, pl. 42, fig. 6, 1844.

Family SAXICAVIDAE

Shell of medium size or large, rather elongate, somewhat earthy like *Mya*, gaping at each end, widely at the posterior end; valves equal or nearly so, sometimes not completely covering the animal; cardinal areas not differentiated; sculpture rude, often of concentric ripples; hinge without lateral teeth and with one or two small cardinal teeth, or edentulous, and with a developed numph or produced flange acting as a base for the posterior external ligament; adductor scars and pallial sinus irregular.

Genus PANOPE Ménard, 1807

Glycimeris Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 83, 1799; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 350, 1856, as of Klein: not *Glycymeris* Da Costa, Brit. Conch., p. 168, 1778.

Panope Ménard de la Groye, Mémoire sur un Nouveau Genre de Coquille bivalve-équivalve de la Famille des Solenoides, pp. 16, 30, January, 1807, *fide* Dall, Proc. Malac. Soc. London, Vol. 10, p. 34, 1912; Ménard de la Goye, Journ. de Physique, Vol. 65, p. 114, August, 1807; not *Panope* Leach, in Brewster's Edinburgh, Encylc., Vol. 7 (2), p. 404, 1814, *Crustacea*.

Panopea Ménard, Ann. Mus. Hist. Nat. Paris, Vol. 9, p. 135, 1807; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 827, 1898.

Panopæa Lamarck, Extr. Cours Zool., p. 108, 1812; Hist. Nat. Anim. s. Vert., Vol. 5, p. 456, 1818; Children, Quart. Journ. Sci., Lit., Arts, Vol. 14, p. 84, 1823; Hist. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 6, p. 65, 1835; Tryon, Struct. Syst. Conch., Vol. 3, p. 136, 1884.

Glycymeris Lamarck, Fischer, Man. Conch., p. 1125, 1887.

Type (virtually by monotypy, designated by Children, 1823), *Panope aldrovandi* Ménard = *Panope glycimeris* (Born), described as *Mya*, Index Mus. Cæs. Vind., p. 10, 1778, figured by Born, Test. Mus. Cæs. Vind., pl. 1, fig. 8, 1780; also figured by Reeve, Conch. Icon., Vol. 19, *Panopæa*, pl. 1, 1873; Mediterranean Sea.

Shell of moderate size or large, elongate, ventricose; umbones not very prominent, subcentral; rudely concentrically sculptured; gaping widely behind, slightly in front; hinge with one small cardinal tooth in each valve beneath the umbo, anterior to a large numph or ligamental ridge.

In 1778 Da Costa used the generic name *Glycymeris* for the taxodont mollusks which Lamarck later named *Pectunculus*. Later Lamarck proposed the name *Glycimeris*, spelled with one "y," for the Saxicavoid burrowers now so generally called *Panope*. This latter name was erected by Ménard de la Groye as a substitute for *Glycimeris* Lamarck, 1799, not *Glycymeris* Da Costa, 1778. Unfortunately, the International Rules of Zoological Nomenclature do not define how different the spelling of two generic names must be to avoid being considered homonyms. Legally, therefore, *Glycimeris* Lamarck, 1799, is not preoccupied by *Glycymeris* Da Costa, and hence should be used for the Saxacavoid burrowers; but as this would be so undesirable, it has been dropped in favor of *Panope* Ménard, a step which will no doubt be approved by a definite suspension of the rules.

According to Dall, Ménard published a separate of his paper on *Panope*, dated January, 1807, in which the name ends with the single vowel "*e*," the abridged paper with *Panopea* appearing later in the Annales of the Paris Museum.

The cardinal teeth of *Panope* are variable in development. They may be almost obsolete, or thin but projecting prominently. The cardinal tooth of the left valve projects more than that of the right valve. *Panomya* tends to have less well developed teeth.

Subgenus **PANOPE**, s. s.

Shell large, the medial region evenly ventricose without a radial depressed area.

Typical *Panope* lacks the depressed medial ara of *Panomya* and is considerably larger. The differences do not seem to be more than subgeneric.

Panope (Panope) generosa Gould

Plate 21, Figures 12*a*, 12*b*

Mya abrupta Conrad, U. S. Exploring Exped. (Wilkes), Vol. 10, p. 723, Geol. Atlas, pl. 17, fig. 5, 1849, = *Panope abrupta* (Conrad); not *Pholadomya abrupta* Conrad, Foss. Shells Tert. Form. N. A., Vol. 1, no. 2, p. 26, pl. 12, Dec., 1832; republished by Harris, same figures, Washington, 1893; Conrad, Foss. Medial Tert., p. 3, pl. 1, fig. 4, 1838; republished by Wagner Free Inst. Sci., Philadelphia, same figures, 1893; = *Panope* (*Margaritaria*) *abrupta* (Conrad), the type of *Margaritaria* Conrad, Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 1, p. 214, July, 1849.

Panopæa generosa Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 215, 1850; U. S. Exploring Exped., (Wilkes), Vol. 12, p. 385, 1852, Atlas Moll., pl. 34, figs. 507, 507*a*, 507*b*, 1856; Keep, West Amer. Shells, p. 90, fig. 81, 1904; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 205, pl. 15, figs. 1, 2, 3, 1924.

Glycimeris generosa Gould, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 350, 1856; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 89, 90, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 241, 1888; Keep, West Coast Shells, p. 209, fig. 178, 1888.

Glycimeris estrellanus Conrad, U. S. Pac. R. R. Repts., Vol. 7, p. 194, pl. 7, fig. 5, 1857.

Panopea abrupta Conrad, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 830, 1898.

Panopea generosa Gould, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 830, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 182, 1903; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 188, pl. 3, fig. 20, 1909; Arnold, Bull. 396, U. S. Geol. Surv., pp. 31, 142, pl. 18, fig. 4, 1910; Bull. 398, pl. 40, same figures, 1910; Keep, West American Shells, Revised Ed., p. 101, fig. 79, 1911; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 154, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Panopea generosa var. *solida* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 831, 1898; U. S. Nat. Mus., Bull. 112, p. 54, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 206, pl. 3, fig. 11, 1924.

Panopea generosa var. *globosa* Dall, *op. cit.*, p. 831, 1898.

Panopea estrellana Conrad, Arnold, Bull. 396, U. S. Geol. Surv., p. 64, pl. 15, fig. 1, 1910; Bull. 398, pl. 37, same figure, 1910.

Panope generosa Gould, Kew, Univ. Calif. Publ. Geol., Vol. 8, p. 46, 1914; English, Vol. 8, pp. 210, 213, 1914; Clark, Vol. 8, p. 419, 1915; Martin, Vol. 9, p. 253, 1916; Nomland, Vol. 10, p. 219, 1917; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 63, pl. 18, fig. 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 54, 1921; Yokoyama, Journ. Faculty Sci., Imp. Univ. Tokyo, Sect. II, Vol. 1, pt. 1, p. 2, 1925; pt. 4, p. 132, 1926; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 470, 1926; E. K. Jordan, Vol. 15, p. 245, 1926; Hanna and Hertlein, Vol. 16, p. 141, 1927.

Panope estrellana Conrad, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916.

Panope (*generosa* Gould var. ?) *tæniata* n. sp. ? Dall, Nautilus, Vol. 32, p. 25, 1918.

Panope abrupta Conrad, Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 308, 1922.

Panope generosum (Conrad), Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922.

Type specimens: Of *abrupta* Conrad, 1849, in the U. S. National Museum, No. 3,608; of *generosa*, location unknown, probably in the U. S. National Museum; of *estrellanus*, in the U. S. National Museum, No. 13,320; of *solida*, *globosa* and *tæniata*, in the U. S. National Museum.

Type localities: Of *abrupta* Conrad, 1849, Astoria, Oregon, Miocene; of *generosa*, Puget Sound, Recent; of *estrellanus*, Panza and Estrella Valleys, California, Miocene; of *solida*, San Francisco, California, Recent; of *globosa*, head of the Gulf of California, Recent; of *tæniata*, Magdalena Bay, Lower California, Mexico, Pleistocene or Recent ?.

Miocene: Astoria, Oregon (Conrad, as *abrupta*); Contra Costa County (Cooper); Estrella, San Luis Obispo County (Conrad, as *estrellanus*); Foxin's, Santa Barbara County (Cooper); ? Vaqueros-Temblor; San Pablo formation of middle California; Santa Margarita formation north of Coalinga, and also near Santa Margarita, San Luis Obispo County (Nomland); lower Neocene (Clark); Bear River Miocene (questionably, Martin); etc.

Pliocene: Jacalitos and Etchegoin formations near Coalinga (Arnold; Nomland); Etchegoin of Sargent oil field, near Sargent, Santa Clara County; Purisima and Merced formations south of San Francisco (Martin); Merced formation near Freestone, Sonoma County (Dickerson); lower Fernando of Elsmere and Holser canyons, Los Angeles County (English); Imperial formation of Coyote Mountain, Imperial County (Kew; Hanna); upper Pliocene at Santa Barbara (Cooper; Arnold); Loreto, Lower California, Mexico; Pliocene of Japan (Yokoyama); etc.

Pleistocene: Santa Barbara to San Pedro (Cooper); "Pliocene" and lower San Pedro series of Deadman Island, rare (Arnold, 1903); "Saugus" formation, near Ventura (Waterfall); upper San Pedro series at Deadman Island, San Pedro, and Los Cerritos (Arnold, 1903); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan); Magdalena Bay, Lower California, Mexico, of Pleistocene or Recent age (Dall, as *tæniata*, 1918); etc.

Recent: Puget Sound to Scammons Lagoon, Lower California, Mexico (Jordan); also Gulf of California; Japan (Yokoyama).

This well-known species lives in fine sand or mud where its very long, united siphons permit it to remain at a considerable depth. Being removed from many surface enemies and from the physical shocks incident upon a more exposed habitat it has a shell which does not completely cover its soft parts. As might be expected of a mud dweller, the shell varies considerably in shape, depending upon the nature of the medium in which it exists. Such variations can be seen in any large collection containing numerous specimens from different localities, and the extremes, when occurring directly with the normal form, may be regarded as abnormalities rather than as incipient species or even varieties. Nothing is gained and trouble is caused by cluttering up the literature with the names of freaks and pathologic individuals, hence such names are here treated as pure synonyms. These remarks apply to the so-called variety *solida* and to *tæniata*. The latter form was described from a single valve found on the beach, which it was suggested may have come from the Pleistocene beds whose fauna was the subject of the paper. It was unfigured and the description sounds like a subterfuge.

Panope estrellana (Conrad) is generally supposed to be more elongate than *P. generosa*, but it does not appear significantly so. It probably came from Santa Margarita beds, upper Miocene in age. Conrad's figure is not unlike some specimens which would unquestionably be identified as *generosa*. In the Temblor horizon, lower middle Miocene, there is an elongate form of *Panope* which Wiedey has recently named *P. tenuis*.[1] The type specimen of this latter form is quite elongate and may represent a valid variety.

The form from the Miocene of Astoria, Oregon, which Conrad named *Mya abrupta* is conspecific with *generosa* Gould. Conrad's name is preoccupied by his *Pholadomya abrupta*, which appears to belong to a subgenus of *Panope*. This latter species is characterized by having four or five radial ridges widely spaced over the medial portion of the valves. Portions of the shell are said to be perlaceous.[2] Deshayes and Milne Edwards[3] considered Conrad's *Pholadomya* a true *Panope*, but it may be subgenerically removed from the typical species.

In a recent paper Dall and Ochsner described *Panope similaris*[4] from deposits presumably of Pliocene age on Indefatigable Island, one of the Galapagos Group. It is similar in general aspect to *generosa*.

Subgenus **PANOMYA** Gray, 1857

Panomya M. E. Gray, Fig. Moll. Anim., Vol. 5, p. 29, pl. 346, fig. 1, 1857, only species, *P. norvegica* (Spengler); Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 832, 1898.

Panopæa Ménard de la Groye, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 351, 1856, corrected to *Panomya* on p. 659, 1858.

Type (by monotypy), *Mya norvegica* Spengler, Acta Soc. Hist. Nat. Hafn., Vol. 3, p. 46, pl. 2, fig. 18, 1793, *fide* Dall, *op. cit.*, p. 832, 1898, (not *M. norwegica* Gmelin,

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[1] Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 154, 155, pl. 20, fig. 4, 1928.

[2] The shell of *P. generosa* is inclined to be earthy, but not so much so as that of *Saxicava*, and the exterior portion of the valves near the umbo is of a texture not far removed from pearly. This feature is generally noticeable only in living specimens.

[3] In Lamarck's Hist. Nat. Anim. s. Vert., Ed. 2, Vol. 6, p. 66, 1835.

[4] Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 125, pl. 5, fig. 1, 1928.

Syst. Nat., Ed. 13, Vol. 1, p. 3222, 1790); figured by M. E. Gray, *op. cit.*, pl. 346, fig. 1, 1857.

Shell smaller than that of *Panope, s. s.*, with a medial radial depressed area producing broad, rounded, radial bounding ridges or folds.

There appears to be little difference in the shells of *Panomya* and *Panope, s. s.*, aside from the smaller size and the medial radial depression of the former. *Panope, s. s.*, is generally proportionately more elongate and does not have the prominent radial folds which define the margins of the depressed portion of the valves of *Panomya*. The pallial sinus of *Panomya* generally appears as a succession of disconnected oval impressions.

Panope (Panomya) arctica (Lamarck)

Mya norvegica Spengler, Acta Soc. Hist. Nat. Hafn., Vol. 3, p. 46, pl. 2, fig. 18, 1793, *fide* Dall, 1898; not of Chemnitz nor Gmelin.

Glycimeris arctica Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 458, 1818.

Panopæa arctica Lamarck, Gould, Invert. Mass., p. 37, fig. 27, 1840.

Panomya norvegica Spengler, Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 832, 833, 1898; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913.

Pliocene: France and Italy; questionably in the Pliocene of Center Creek, Nome district, Alaska (Dall, 1898; in Moffit, 1913).

Pleistocene: Pleistocene of the boreal north Atlantic and Pacific coasts (Dall, 1898).

Recent: Arctic and boreal seas of both hemispheres, on the Pacific south to the Aleutians, and in the Atlantic in cold deep water to the Mediterranean (Dall, 1898).

Spengler's work has not been available for reference. Gould's drawing of *Panopæa arctica* Lamarck illustrates a shell more strongly radially constricted than most specimens labelled *P. ampla* Dall in the Stanford collections. Dall (1898) has given a number of synonymic references not included above.

Panope (Panomya) ampla (Dall)

Plate 21, Figures 10*a*, 10*b*

"*Panopæa norvegica* Spengler" Middendorff, Beitr. Malac. Rossica, Pt. 3, p. 78, pl. 20, fig. 11, 1849, in part, not of Spengler, *fide* Dall, 1898.

Panomya ampla Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 833, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 183, 1903; Dall, Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 121, 1904, reissued by the Smithsonian Inst., 1910; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, pp. 45, 46, 1913; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 593, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 253, 1916; Moody, Vol. 10, p. 45, 1916; Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919, questionably; U. S. Nat. Mus., Bull. 112, p. 121, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 207, pl. 10, fig. 3, 1924.

Panomya (*ampla* var. ?) *chrysis* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 133, pl. 11, fig. 7, 1909.

Shell ovate-subquadrate, rather heavy, gaping very widely in the rear, medial portions of valves depressed and bounded by radial folds; pallial sinus appearing as a series of irregular, often oval, impressions. Size (of normal Recent specimen from Departure Bay, British Columbia): Length, 62 mm.; height, 41 mm.; convexity of one valve, 11 mm. (left).

Type specimens: Of *ampla*, in the U. S. National Museum, No. 151,221 (*fide* Oldroyd); of *chrysis*, No. 154,093.

Type localities: Of *ampla*, Aleutian Islands, Recent; of *chrysis*, Goldwasher's Gully, Coos Bay, Oregon, Miocene.

Miocene: Empire formation of Coos Bay, Oregon (Dall, 1909, as var. *chrysis;* Arnold and Hannibal; Howe)

Pliocene: Coos conglomerate, Coos Bay, Oregon (Howe); Merced and Purisima formations of San Francisco. (Arnold; Martin); middle Wildcat formation of Humboldt County (Martin); Pliocene of Nome, Alaska (Dall, in Moffit), and questionably of St. George Island, Pribilof Group (Dall, 1919); Fernando of Los Angeles (Moody).

Pleistocene: North Pacific, Bering, and Okhotsk seas (Dall); Douglas Island, Juneau Harbor, Alaska (Dall, 1904); "Pliocene" of Deadman Island, rare (Arnold).
Recent: Arctic Ocean, Aleutian Islands, southeast to Puget Sound.

"Panomya chrysis" Dall is not recognizably distinct from *P. ampla* Dall. This species is heavier shelled and more irregular in shape than the young of *Panope* (*Panope*) *generosa* Gould.

Genus SAXICAVA Fleuriau de Bellevue, 1802

Hiatella F. M. Daudin, in L. A. G. Bosc, in Castel's new edit. of Hist. Nat. de Buffon, Coquilles, Vol. 3, p. 120, Paris (Déterville), 1802 (? 1801).

Saxicava Fleuriau de Bellevue, Bull. Soc. Philom., No. 62, pp. 5, 10, 1802; Children, Quart. Journ. Sci., Lit., Arts, Vol. 14, p. 302, 1823; Gray, Proc. Zool. Soc. London for 1847, p. 193, 1847; Herrmannsen, Indicis Gen. Malac., Vol. 2, p. 415, 1848; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 589, 1896; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 833, 1898.

Agina Turton, Conch. Insul. Brit., Dithyra, p. 54, 1822, only species *Mya purpurea*.

Type (by subsequent designation,[1] Children, 1823), *Mytilus rugosus* Linnæus, 1767.

Shell small, irregular, very inequilateral, the young with a cardinal tooth as in *Panomya* but the adult with the teeth obsolete; pallial line discontinuous. Animals burrowing in habit.

Saxicava arctica (Linnæus)

Mya arctica Linnæus, Syst. Nat., Ed. 12, p. 1113, 1767; Fabricius, Fauna Groenl., p. 407, 1780; Hanley, Ipsa Linn. Conch., p. 28, 1855.

Solen minutus Linnæus, Syst. Nat., Ed. 12, p. 1115, 1767; Chemnitz, Neues Syst. Conch. Cab, Vol. 6, p. 67, pl. 6, fig. 51, 1782; Montagu, Test. Brit., p. 53, pl. 1, fig. 4, 1803; Wood, Index Test., p. 16, pl. 3, *Solen*, fig. 33, 1825; Gen. Conch., p. 139, pl. 34, figs. 5, 6, 1835; Lamarck, Hist. Anim. s. Vert., Desh. Milne Edw. Ed., Vol. 6, p. 57, 1835.

Cardita arctica Bruguière, Encycl. Méthod., Vol. I, p. 411, pl. 234, figs. 4*a*, 4*b*, 1792.

Hiatella monoptera Bosc, Hist. Nat. Coq., Vol. 3, p. 120, pl. 21, fig. 1, 1801; *fide* Bucquoy, Dautzenberg, and Dollfus, 1896.

Didonta bicarinata Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 125, pl. 6, figs. 2*a*, 2*b*, 1817.

Hiatella arctica Linnæus, Lamarck, Hist. Anim. s. Vert., Vol. 6, p. 30, 1819.

Saxicava arctica Linnæus, Philippi, Enum. Moll. Sicil., Vol. 1, p. 20, pl. 3, figs. 3, 3*a-d*, 1836; Forbes and Hanley, Brit. Moll., Vol. 1, p. 141, Vol. 4, pl. 6, figs. 4-6, 1853; Sars, Moll. Reg. Arct. Norv., pp. 95, 96, pl. 20, figs. 8*a-c*, 1855; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 16, 1857; Sowerby, Thes. Conch., Vol. 5, p. 132, pl. 471, fig. 1, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 292, 1889; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, pp. 589-597, 1896; Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896; Trans. Wagner Inst. Sci., Vol. 3, pp. 834, 835, 1898; Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 121, 1904, reissued by the Smithsonian Inst., 1910; Lamy, Journ. Conchyl., Vol. 57, p. 248, 1909; Dautzenberg and Fischer, Res. Camp. Sci. Albert 1, Prince de Monaco, Fasc. 37, pp. 504-510, 1912; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913; Dall, Canadian Arctic Exped., Vol. 8, Pt. A, p. 29A, 1919; U. S. Nat. Mus., Bull. 112, p. 55, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 208, pl. 9, fig. 6, pl. 51, fig. 4, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Saxicava ungana Grewingk, Russisch-Kaiserliche Mineralogische Gesellschaft zu St. Petersburg, Verhandlungen for the years 1848 and 1849, p. 354, pl. 6, figs. 1*a-c*, 1850; Dall, Wash. Acad. Sci., Alaska, Res. Harriman Alaska Exped., Vol. 4, p. 117, 1904, reissued by the Smithsonian Inst., 1910.

Saxicava insita Conrad, Amer. Journ. Conch., Vol. 5, p. 40, 1869.

Miocene: St. Paul Island, Nushagak, Atka Island, Morshowi, Pavloff Bay, Unga Island, Kadiak Island, Alaska (Dall, 1896, 1904); Unga, Alaska (Grewingk, Tertiary, as *S. ungana*).[2]
Pliocene: Center Creek, Otter Creek, second beach 1½ miles east of Nome, Alaska (Dall in Moffit).

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[1] The original descriptions of *Saxicava* and of *Hiatella* have not been available. We have assumed that *Mytilus rugosus*, which was designated as type of *Saxicava* by both Children, 1823, and by Gray, 1847, was included by Fleuriau de Bellevue in his original list of species of *Saxicava*. *Hiatella* may have been published earlier than *Saxicava*, but we have used the more familiar name *Saxicava* in the belief that a suspension of the rules could be obtained in order to protect it should the matter of priority favor *Hiatella*.

[2] Eichwald, p. 127, 1871, attributes *ungana* to the Cretaceous. See the note on *Mya arenaria* variety *profundior*, p. 414

Pleistocene: Northwest Territories, Canada (Dall, 1919); Douglas Island, Juneau Harbor, Alaska (Dall, 1904); lower San Pedro of Nob Hill cut, San Pedro (T. S. Oldroyd, 1925); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan).
Recent: Arctic Ocean to Panama; also Atlantic (Dall, 1921).

In establishing this species Linnæus gave no reference, but Hanley found a specimen in the Linnæan collection which can be considered authentic. According to Hanley, Linnæus wrote in his manuscript "cardine subedentulo" which accords better with the species than "cardine edentulo," as printed in the Systema Naturæ. This has been discussed by Bucquoy, Dautzenberg, and Dollfus. According to these latter authors *S. arctica* lives in deeper water than *S. rugosa* and is attached by a byssus to the surface of large shells such as *Pecten*, whereas, *S. rugosa* does not use a byssus but lives in holes in rocks. In shape *arctica* is generally more inequilateral and more elongate and quadrangular than *rugosa*. The latter is practically edentulous, whereas *arctica* has one tooth in the right valve and two in the left.

Sars figured a specimen of *arctica* which has well-developed spines in two radial series running posteriorly from the umbonal region, the lower one to the posterior ventral margin of the valve, the upper to the posterior dorsal margin. These spines may be obsolete or eroded off in many specimens, especially in mature examples.

Saxicava pholadis is smoother and lacks the spines. It is also more evenly rounded on the ends.

Saxicava pholadis (Linnæus)

Mytilus pholadis Linnæus, Mantissa, Vol. 2, p. 548, 1767; Chemnitz, Neues Syst. Conch. Cab., Vol. 8, p. 154, pl. 82, figs. 735, 735*b*, 1785.
Mya byssifera Fabricius, Fauna Groenl., p. 408, 1780.
Saxicava pholadis Linnæus, Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 502, 1818; Sars, Moll. Reg. Arct. Norv., p. 95, pl. 20, figs. 7*a-c*, 1855; Reeve, Conch. Icon., Vol. 20, *Saxicava*, pl. 1, fig. 5, 1875; Dautzenberg and Fischer, Res. Camp. Sci. Albert 1, Prince de Monaco, Fasc. 37, pp. 510-512, pl. 11, figs. 34-40, 1912; Dall, Canadian Arctic Exped., Vol. 8, Pt. A, p. 29A, 1919; Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; U. S. Nat. Mus., Bull. 112, p. 55, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 209, pl. 51, fig. 5, 1924.

Type specimen: In the British Museum, *fide* Oldroyd.

Type locality: Greenland.

Pliocene: Late Pliocene of St. George Island, Pribilof Group (Dall, 1919).
Pleistocene: Northwest Territories, Canada (Dall, Canadian Arctic Exped.).
Recent: Arctic Ocean to Panama; also Atlantic (Dall, 1921).

This species has been confused with *rugosa* and possibly in some cases with *arctica*. It is edentulous, strongly concentrically wrinkled and spineless. It is generally much less quadrate than *arctica* and differs from the latter in its edentulous hinge. Sars figures well the hinge characters of these two species. However, it is possible that the whole series belong to a single species, very variable in form because of its burrowing habit.

Saxicava rugosa (Linnæus)

Mytilus rugosus Linnæus, Syst. Nat. Ed. 12, p. 1156, 1767; Pennant, Zool. Brit., Vol. 4, p. 110, pl. 63, fig. 72, 1777; Dillwyn, Descr. Cat. Rec. Shells, Vol. 1, p. 304, 1817, in part, but not all of his synonymy; Hanley, Ipsa Linn. Conch., p. 139, 1855.
Saxicava rugosa Linnæus, Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 501, 1818; Desh. & Milne Edw. Ed., Vol. 6, p. 152, 1835; Brown, Illust. Conch. Gt. Brit. Irel., Ed. 2, p. 103, pl. 48, figs. 14, 16, 1844; Forbes and Hanley, Brit. Moll., Vol. 1, p. 146, pl. F, fig. 6, Vol. 4, pl. 6, figs. 7, 8, 1853; H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 349, pl. 94, figs. 1, 1*a*, 1*b*, 1858; Reeve, Conch. Icon., Vol. 20, *Saxicava*, pl. 1, fig. 3, 1875; Sowerby, Thes. Conch., Vol. 5, p. 133, pl. 471, fig. 3, 1887; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, pp. 597-602, pl. 86, figs. 12-14, 1896; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913.

Pliocene: Submarine beach ½ mile west of Nome, Alaska (Dall, in Moffit); Pliocene of Coralline and Red Crags of England; Holland; etc.
Pleistocene: Ireland, England, etc.
Recent: North Sea, North Atlantic, Baltic, Mediterranean.

Dall reported this species in the Pliocene near Nome, Alaska. The identification is open to question.

This species is similar to *S. pholadis* and *S. arctica*. Bucquoy, Dautzenberg, and Dollfus have given in detail the differential characters in their important work on the Roussillon mollusks referred to above, and have discussed the reference by Linnæus to a figure in Gualtieri which happens to be a *Unio*. Pennant's figure of *Mytilus rugosus* has been generally accepted as a correct representation of *rugosa*.

Genus CYRTODARIA Reuss, 1800

Cyrtodaire Daudin, Bull. Sci. Soc. Philom. Paris, No. 22, p. 170, January, 1799, vernacular use, *fide* Sherborn, Index Anim., Sect. 1.
Cyrtodaria G. Cuvier, Lecons Comp. Anat., Vol. 1, p. 5, 1800, *nomen nudum, fide* Sherborn, *op. cit.*
Cyrtodaria J. D. Reuss, Repertorium Commentationum a Societatibus Litterariis editarum Scientia Naturalis, p. 351, 1800 or 1801 ? *fide* Dall, 1898; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 835, 1898.

Type (*fide* Dall, 1898), *Cyrtodaria siliqua* Daudin.

Dall (1898) and others attribute this genus to Daudin, 1799, but Sherborn considers Daudin's use of the name entirely vernacular. *Cyrtodaria*, according to Sherborn, was used by Cuvier as a *nomen nudum* in 1800. Dall (1848) refers to "*Cyrtodaria* Reuss, Repertor. Comm., p. 351, 1800" which the British Museum catalogue of natural history books indicates was issued in two volumes in 1801-1802. Not having had access to any of the original sources indicated above, we have tentatively accepted the genus with the type as indicated by Dall until an opportunity to consult the desired literature is forthcoming. However, we have assigned the genus to Reuss in the belief that Daudin's use of it was entirely vernacular.

Cyrtodaria camdenensis Dall

Cyrtodaria camdenensis Dall, U. S. Geol. Surv., Prof. Paper 125-C, pp. 33, 34, pl. 5, fig. 7, 1920.

Type specimen: In the U. S. National Museum.

Type locality: Carter Creek, Arctic coast, in the Camden Bay region; Pliocene.

Pliocene: At the type locality (Dall).

Superfamily PHOLADACEA

Family PHOLADIDAE

Shell elongate or ovate to subglobose, beaks very inconspicuous; valves equal or nearly so; hinge edentulous, ligament and resilium absent or obsolete; accessory shelly plates protecting marginal portions of valves; pallial sinus present; styloid apophysis generally prominent; anterior dorsal margin generally reflected over exterior of shell; sculpture often reticulate, sometimes spiny and generally more prominent on anterior portion of valves.

The Pholads, or rock-borers, are widely distributed and date from an early geologic age, possibly the Carboniferous. Some of the species are widely distributed, perhaps due to their dispersal on floating timbers. The anatomy of the group has been studied by Poli, Deshayes, Fischer, and others, but the first important attempt at a systematic arrangement appears to have been made by Gray.[1] Tryon[2] and Fischer[3] made some changes and elaborations, and Dall's[4] arrangement, so far as it goes, is helpful. Much further study appears to be necessary before the relative systematic value of the several characters used in classification can be determined. S. P. Woodward remarked that the dorsal shields were only of specific value, whereas Gray used the characters of the accessory plates as the fundamental basis of his classification.

Due to the peculiar anatomy of the *Pholadidæ* a number of terms have been used which are only applicable to this group and hence are less familiar than more commonly applied terms. It seems advisable to define these here briefly and to use them in the descriptions in order to avoid a certain amount of repetition or circumlocution.

One of the distinctive peculiarities of the *Pholadidæ* is the presence of accessory plates placed over the margins of the valves at their vulnerable points. These plates are often missing from museum specimens, and they are rarely found with fossils. They may be calcareous or corneous. The plate on the dorsal margin of the shel , anterior to the beaks, is called a *protoplax*, which may be double or single. A single plate, often transverse to the long axis of the shell and in approximately the middle position, is called the *mesoplax*. Behind this there frequently occurs a *metaplax*. In a few cases, such as in *Martesia*, a ventral plate, called a *hypoplax*, is also present. Any or all of these plates may be absent or much reduced in size. In addition to these accessory plates, in some forms the posterior extremity of each valve is prolonged by a corneous appendix to which is sometimes connected a calcareous trough called a *siphonoplax*. This may be a complete tube showing no suture. The anterior portion of the shell may be nearly or completely closed by the valves, a large hiatus or open gape may occur, or a hiatus in the valves may be present but completely closed over by a calcareous wall called a *callum*. In the interior of the shell a prominent, often concave or spoon-shaped, projecting arm extends from the umbonal portion of the shell. This is sometimes called the *styloid apophysis*. The other parts of the shell need no special nomenclature.

Subfamily PHOLADINAE

Anterior gape or hiatus permanently open; no callum.

Genus PHOLAS Linnæus, 1758

Pholas Linnæus, Syst. Nat., Ed. 10, p. 669, 1758; Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 90, 1799; Children, Quart. Journ. Sci., Lit., Arts, p. 82, 1822, type *P. dactylus* Linnæus; Fischer, Man. Conchyl., p. 1132, 1887; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 609. 1896; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 814, 1898.

Hypogæoderma Poli, Test. Sicil., Vol. 2, pp. 251, 257, 1795.

Dactylina Gray, Proc. Zool. Soc. London for 1847, p. 187, 1847, type *Pholas dactylus* Linnæus; Fischer, Man. Conchyl., p. 1133, 1887.

Thovana Leach MS., Gray, Proc. Zool. Soc. London for 1847, p. 187, 1847, type, *Pholas oblongatus*.

Pragmopholas Fischer, Man. Conchyl., p. 1133, 1887.

"*Phragmopholas* Fischer," Dall, *op. cit.*, p. 814, 1898, misspelling of or emendation of *Pragmopholas*.

Type (by subsequent designation, Children, 1822), *Pholas dactylus* Linnæus, Syst. Nat., Ed. 10, p. 669, 1758; figured in Reeve, Conch. Icon., Vol. 18, *Pholas*, pl. 2, figs. 4*a*, 4*b*, 1872; discussed and figured by Bucquoy, Dautzenberg, and Dollfus, Moll. Mar.

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[1] Ann. Mag. Nat. Hist., Ser. 2, Vol. 8, pp. 380-386, 1851.

[2] Proc. Acad. Nat. Sci. Phila., Vol. 14, pp. 191-221, 1862.

[3] Man. Conchyl., pp. 1130-1137, 1887.

[4] Trans. Wagner Inst. Sci., Vol. 3, pp. 814-821, 1898.

Roussillon, Vol. 2, pp. 609-615, pl. 87, figs. 1-5, 1896; Atlantic from England to Gibraltar and the Mediterranean, Recent; also European Pliocene and Pleistocene.

Shell equivalve, elongate-cylindric, generally gaping somewhat anteriorly and never closed by a callum; sculpture of radial spinose lamellæ, accentuated on the anterior portion of the shell; posterior margin of valves without cyathiform appendix; styloid apophysis large, concave; with one or more accessory plates, or all plates obsolete.

Subgenus **PHOLAS**, s. s.

Shell gaping anteriorly; dorsal region with two protoplaxes.

The typical subgenus does not appear to be represented in the California region.

Subgenus **BARNEA** Risso, 1826

Barnea Leach MS., Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 376, 1826, only species, *B. spinosa* Risso, unfigured; Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, pp. 194, 207, 1862; Fischer, Man. Conchyl., p. 1133, 1887; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 615, 1896; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 815, 1898.

Barnia Leach MS., Gray, Synop. Cont. Brit. Mus., Ed. 44, p. 76, 1842, *fide* Sherborn.

Holopholas Fischer, Man. Conchyl., p. 1133, 1887.

Type (by monotypy), *Barnea spinosa* Risso, *op. cit.*, p. 376, 1826, = *Pholas candidus* Linnæus, Syst. Nat., Ed. 10, p. 669, 1758; figured in Reeve, Conch. Icon., Vol. 18, *Pholas*, pl. 1, fig. 1, 1872; also figured and discussed by Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, pp. 615-620, pl. 88, figs. 1-7, 1896; Atlantic, Mediterranean, etc.

Shell not gaping in front; sometimes with only one accessory plate, a lanceolate protoplax, sometimes with a transverse mesoplax also.

Barnea has a very small gape or entirely lacks the anterior gape of typical *Pholas*.

Section Barnea, s. s.

With one accessory plate, a lanceolate protoplax.

Section Scobinopholas, new name

Scobina Bayle, Journ. Conchyl., Vol. 28, p. 242, 1880, new name for *Pholas* Linnæus of H. & A. Adams, type, *Pholas costata* Linnæus; not *Scobina* Lepeletier, Encycl. Méth., Insecta, Vol. 10, p. 574, 1825, Hymenoptera.

Type: Pholas costatus Linnæus.

With two accessory plates, a lanceolate protoplax and a transverse mesoplax.

As *Scobina* was used for a group of insects many years before its application to mollusks, we have substituted *Scobinopholas* as a new name with *Pholas costatus* as type. This group is the typical *Pholas* of Lamarck, 1801,[1] but not 1799.

Pholas (Barnea) costatus Linnæus

Pholas costatus Linnæus, Syst. Nat., Ed. 10, p. 669, 1758, Wood, Gen. Conch., pl. 15, figs. 1, 2, 1815; Lamarck, Hist. Anim. s. Vert., Vol. 5, p. 445, 1818; Ed. 2, Vol. 6, p. 45, 1835; Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, p. 201, 1862; Reeve, Conch. Icon., Vol. 18, *Pholas*, pl. 1, figs. 2*a*, 2*b*, 1872.

Pholas virginianus Lister, Hist. Conch., Ed. 2, pl. 5, fig. 434, 1770.

Barnea (*Scobina*) *costata* Linnæus, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 816, 1898.

Barnea costata Linnæus, Dall, U. S. Nat. Mus., Bull. 37, p. 72, pl. 68, fig. 9, 1889; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 462, pl. 28, figs. 5, 6, 1926.

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[1] Syst. Anim. s. Vert., p. 127, only example given *Pholas costatus* Linnæus. In the Prodrome, 1799, Lamarck gave *P. dactylus* as example.

Pliocene: Coyote Mountain, western Imperial County, California (Hanna); Caloosahatchie marls, Florida (Dall).
Pleistocene: Massachusetts, Maryland, South Carolina, Florida (Dall).
Recent: Massachusetts south to Mexico and Brazil (Dall).

Subgenus **ZIRFAEA** Gray, 1842

Zirfæa Gray, Synop. Cont. Brit. Mus., Ed. 42, p. 150, 1840, *nomen nudum, fide* Iredale, Proc. Malac. Soc. London, Vol. 10, p. 298, 1913; Synop. Cont. Brit. Mus., Ed. 44, p. 76, 1842; diagnosis, no species, *fide* Iredale; Proc. Zool. Soc. London for 1847, p. 188, 1847, type designated, "*Ph. crispata;*" Ann. Mag. Nat. Hist., Ser. 2, Vol. 8, pp. 381, 385, 1851, generic name attributed to "Leach MSS."; Fischer, Man. Conchyl., p. 1133, 1887; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 817, 1898.
Zirphæa Leach, Mollusc. Brit. Synop., pp. 250, 252, 1852; Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, pp. 194, 210, 1862.

Type (by subsequent designation, Gray, 1847), *Pholas crispatus* Linnæus.

Shell with a large anterior gape; accessory plates rudimentary or wanting; a radial sulcus dividing each of the valves into two areas.

The shells of this subgenus are oval in shape and have a large anterior gape which is quite conspicuous.

Pholas (Zirfæa) crispatus (Linnæus)

Mya crispata Linnæus, Syst. Nat., Ed. 10, p. 670, 1758.
Pholas crispata Linnæus, Syst. Nat., Ed. 12, p. 1111, 1767; Reeve, Conch. Icon., Vol. 18, *Pholas*, pl. 3, fig. 9, 1872.
Pholas bifrons Da Costa, Brit. Conch., p. 242, pl. 16, fig. 4, 1778.
Pholas parva Da Costa, *op. cit.*, p. 247, 1778, young.
Solen crispus Gmelin, Syst. Nat., Ed. 13, p. 3228, 1791.
Zirfæa crispata Linnæus, Gray, Ann. Mag. Nat. Hist., Ser. 2, Vol. 8, p. 385, 1851; Dall, U. S. Nat. Mus., Bull. 37, p. 72, pl. 68, fig. 10, 1889; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 817, 818, 1898.
Zirphæa crispata Linnæus, Leach, Mollusc. Brit. Synop., p. 252, 1852; Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, p. 211, 1862.

Pliocene: Atlantic coast Pliocene (Dall).
Pleistocene: Labrador and boreal eastern America (Dall, 1898).
Recent: South Carolina to Arctic Ocean; also eastern Atlantic coast.

This species occurs on the Atlantic coast of North America from the Pliocene to the Recent, and is living from South Carolina to the Arctic. However, there is as yet no authentic report of its occurrence on the Pacific coast. Carpenter, Nomland, and others who listed it probably had *gabbi* (Tryon) or *Pholadidea ovoidea* (Gould). *Pholas* (*Zirfæa*) *crispatus* Linnæus is much shorter and higher than *gabbi* of the Pacific coast.

Pholas (Zirfæa) gabbi (Tryon)

Plate 24, Figure 2

Zirfæa gabbi Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 15, p. 144, pl. 1, fig. 1, 1863, *Zirphæa;* Tryon, Amer. Journ. Conch., Vol. 3, Pt. 3, Appendix p. 6, 1868; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 270, 1888, *Zirphæa;* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 184, 1903, *Zirphæa;* Dall, U. S. Nat. Mus., Bull. 112, p. 55, 1921; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 63, pl. 18, fig. 1, 1920; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 210, pl. 36, fig. 1, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929, *Zirphæa.*
"*Zirphæa crispata* Linnæus," Carpenter and others, not of Linnæus.
Not "*Zirphæa gabbii* Tryon," Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 52, 53, pl. 15, fig. 10, 1868-9, = *Pholadidea ovoidea* (Gould).
? "*Zirphæa* aff. *crispata* (Linné)," Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 301, 1917.

Type specimen: In the Academy of Natural Sciences of Philadelphia.

Type locality: California or Japan, Recent, *fide* Tryon and Gabb.

? Miocene: Alameda County (Cooper); ? Santa Margarita formation, upper Miocene, north of Coalinga (Nomland).
Pliocene: Middle Etchegoin, middle Pliocene of the General Petroleum Corporation well, Stiles No. 1, near McFarland, Kern County, depth 3900-18 feet (H. R. Gale); "Pico" near Ventura (Waterfall).
Pleistocene: "Quite rare in the upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island" (Arnold); Pleistocene of San Quintin Bay, Lower California, Mexico (Orcutt).
Recent: Bering Sea and islands and south to San Diego, California; also Japan (Oldroyd).

This species is closely allied to *crispatus*, but is proportionately much longer. Gabb's figure of *gabbi* represents *Pholadidea ovoidea* (Gould), which is a short stumpy form with a calcareous callum that may be broken away leaving a large, open anterior gape.

Pholas (Zirfæa) dentatus (Gabb)

Zirphæa dentata Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 18, 1866, pl. 3, figs. 31, 31*a*, 1868-9; Arnold, U. S. Geol. Surv., Bull. 396, pp. 17, 21, 25, 26, 27, pl. 7, fig. 5, 1910; Bull. 398, pl. 29, fig. 5, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 421, pl. 63, figs. 1, 2, 1915.

Type locality: East end of Kirker's Pass, Contra Costa County; possibly Miocene.

Miocene: Vaqueros formation (including the Temblor), lower Miocene of middle California (Arnold); upper and lower San Pablo, upper Miocene of middle California (Clark).
Pliocene: Jacalitos formation of Coalinga region, lower Pliocene (Arnold).

According to Gabb, "This shell is closely allied to *Z. crispata* but differs in its more regularly cylindrical form, the marked reflection of the posterior dorsal margin, and the angular dentated dorsal plate."

Subfamily MARTESIINAE

Anterior gape or hiatus closed in the adult by a callum.

The subfamily name *Jouannetinæ* Tryon is based upon *Jouannetia*,[1] which dates from 1828. We have substituted *Martesiinæ*, based upon *Martesia*, which dates from 1824. However, the subfamily distinctions are artificial, and may not be of value.

Genus PHOLADIDEA Goodall in Turton, 1819

Pholadidea Goodall, Turton, Conch. Dict., p. 147, 1819; Gray, Proc. Zool. Soc. London for 1847, p. 188, 1847, type *Phol. papyracea;* Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, pp. 194, 212, 1862; Fischer, Man. Conchyl., pp. 1133, 1134, 1887; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 818, 1898.
Pholidæa Leach, Swainson, Treat. Malac., p. 364, only species, *P. papyracea.*
Pholadidæa Turton, Gray, Ann. Mag. Nat. Hist., Ser. 2, Vol. 8, 1851.

Type (by monotypy), *Pholadidea loscombiana* Goodall, = *Pholas papyraceus* Turton, Conch. Insul. Brit., Dith., p. 2, pl. 1, figs. 1-4, 1822, also figured by Jeffreys, Brit. Conch., Vol. 3, p. 116, pl. 4, fig. 2, 1865, Vol. 5, p. 193, pl. 53, figs. 2, 3, 1869; coasts of England, France, etc.

Shell with a double or single protoplax and with or without other accessory plates, the valves prolonged posteriorly into leathery or testaceous cups or a tube (siphonoplax) protecting the siphons.

Subgenus **PHOLADIDEA**, s. s.

With a double, rather small protoplax, a cup-like siphonoplax and generally without other accessory plates; a single radial sulcus present.

The section *Penitella* Valenciennes (in Du Petit-Thouars, Voy. Venus, Atlas Moll., pl. 24, 1846) differs from the typical section of *Pholadidea* in that a small mesoplax is present and the two parts of the protoplax are confluent. The type is *P. conradi* Valenciennes, which is a synonym of *P. penita* Conrad.

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[1] Des Moulins, Bull. Hist. Nat. Soc. Linnéenne de Bordeaux, Vol. 2, p. 244, 1828, monotype, *J. semicaudata* Des Moulins, Miocene of France.

Pholadidea (Pholadidea) penita (Conrad)

Plate 24, Figures 1*a*, 1*b*

Pholas penita Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 237, pl. 18, fig. 7, 1837.

? *Pholas concamerata* Deshayes, Guerin's Mag. Zool., 1840, pl. 17, *fide* Tryon, 1862; Sowerby, Thes. Conch., Vol. 2, p. 497, pl. 106, figs. 67, 68, 1849.

Penitella conradi Valenciennes, Voy. Venus, Atlas Moll., pl. 24, fig. 1, 1846; Conrad, Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 2, p. 335, 1854.

Penitella penita Conrad, Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, p. 215, 1862; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 88, 1868-9.

Pholadidea penita Conrad, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 637, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 259, 1888; Keep, West Coast Shells, p. 212, fig. 181, 1888, 1892; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 134, 1909; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 288, pl. 30, figs. 3*a*, 3*b*, 1918; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 64, pl. 19, fig. 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 55, 1921; I. S. Oldroyd, Stanford, Univ. Publ. Geol., Vol. 1, p. 211, pl. 21, fig. 10, pl. 51, figs. 3*a*, 3*b*, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925.

Pholadidea (*Penitella*) *penita* Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 184, 1903.

? *Pholadidea penita concamerata* Deshayes, Dall, U. S. Nat. Mus., Bull. 112, p. 55, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 211, pl. 22, figs. 4, 5, 1924.

Type specimens: Of *penita*, possibly in the Academy of Natural Sciences of Philadelphia; of *concamerata*, in the British Museum.

Type localities: Of *penita*, near San Diego or Santa Barbara, California, Recent; of *concamerata*, Monterey, California, Recent.

Miocene: Empire formation of Coos Bay, Oregon (Dall, 1909).
Pliocene: Santa Barbara (Gabb; Cooper).
Pleistocene: Lower San Pedro of Nob Hill cut, San Pedro, plentiful (T. S. Oldroyd); upper Pleistocene southwest of Goleta (coll. by Grant); upper San Pedro series of San Pedro, Los Cerritos, Crawfish George's and Deadman Island (Arnold).
Recent: Chirikoff Islands, Alaska, to San Diego, California (Dall, 1921).

This species is close to *P. ovoidea* (Gould), which is shorter, more ovoid, and has a vacant space between the umbonal plate and the umbo. In *penita* the plate is closely appressed to the umbo. *P. concamerata* (Deshayes) has recently been considered a valid variety. Gabb's report of an occurrence in the Post-Pliocene of Santa Barbara may refer to the late Pleistocene deposits near the coast several miles west of the town. Well-preserved specimens occur in the terrace deposit a few miles southwest of Goleta (locality 74).

Pholadidea penita (Conrad) is the type of *Penitella* Valenciennes, a section which may be disregarded.

Pholadidea (Pholadidea) ovoidea (Gould)

Pholas ovoidea Gould, Proc. Boston Soc. Nat. Hist., Vol. 4, p. 87, 1851; Boston Journ. Nat. Hist., Vol. 6, p. 388, 1853; Reeve, Conch. Icon., Vol. 18, *Pholas*, pl. 12, figs. 49*a*, 49*b*, 1872.

Penitella spelæa Conrad, U. S. Pac. R. R. Repts., Vol. 5, p. 326, pl. 5, figs, 43, 43*a*, 43*b*, 1858.

Pholadidea ovoidea Gould, Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, p. 213, 1862; Arnold, Smithsonian Misc. Coll., Vol. 50, p. 444, pl. 55, figs. 1*a*, 1*b*, 1907; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 288, pl. 30, figs. 1*a*, 1*b*, 2*a*, 2*b*, 1918; Dall, U. S. Nat. Mus., Bull. 112, p. 56, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 212, pl. 21, figs. 5, 6, pl. 51, figs. 1*a*, 1*b*, 2*a*, 2*b*, 1924.

? *Zirphæa crispata* Linnæus, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 602, 611, 637, 682, 1864; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 230, 1917.

"*Zirphæa gabbii* Tryon," Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 52, pl. 15, fig. 10, 1868-9, not of Tryon.

Type locality: Monterey, California; Recent.

? Pliocene: Middle Etchegoin of the Coalinga region, middle Pliocene (Nomland, as *Zirphæa crispata*).
Pleistocene: San Pedro (Gabb, as *Z. gabbii*).
Recent: Bering Sea to Gulf of California (Dall).

The very short ovoid form serves to characterize this species. It is amply figured in the publications of Gould, Reeve, and Oldroyd.

Subgenus **PARAPHOLAS** Conrad, 1849

Parapholas Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 4, p. 121, 1849; Journal Acad. Nat. Sci., Phila., Ser. 2, Vol. 1, pt. 3, p. 214, August, 1849; pt. 4, p. 279, January, 1850; Vol. 2, p. 335, 1854; Tryon, Proc. Acad. Nat. Sci. Phila., Vol. 14, pp. 194, 212, 1862, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 819, 1898.

Type (by monotypy), *Pholas californicus* Conrad.

With one large protoplax; mesoplax and metaplax present, double but not confluent; double hypoplax present; valves with two radial sulci, the posterior sometimes obsolete; siphonal appendix thin, horny, not attached to a calcareous tube formed in the burrow of the animal.

Pholadidea (Parapholas) californica (Conrad)

Pholas californica Conrad, Journ. Acad. Nat. Sci. Phila., Ser. 1, Vol. 7, p. 236, pl. 18, fig. 5, 1837; Ser. 2, Vol. 2, p. 335, 1854.

Pholas janelli Deshayes, Proc. Zool. Soc. London for 1839, p. 357.

Parapholas californica Conrad, Proc. Acad. Nat. Sci. Phila., for 1848, p. 121; Tryon, Vol. 14, p. 214, 1862; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913; Weymouth, Calif. Fish and Game Comm., Fish Bull. No. 4, p. 64, pl. 19, fig. 1, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 55, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 210, pl. 22, figs. 7, 13, pl. 36, figs. 2*a*, 2*b*, 1924.

Type locality: San Diego or Santa Barbara, California; Recent.

Miocene: Empire formation of Coos Bay, Oregon (Arnold and Hannibal).
Pliocene: Coos conglomerate, Coos Bay, Oregon (Howe).
Recent: Monterey to San Diego, California (Dall, 1921).

CLASS SCAPHOPODA

ORDER SOLENOCONCHA

Family DENTALIIDAE

Shell greatest in diameter at the oral opening. Width of the median tooth of the radula double its height; foot with an encircling epipodial sheath which is discontinuous, interrupted on the side next to the head. (Pilsbry and Sharp, 1897.)

Genus DENTALIUM Linnæus, 1758

Dentalium Linnæus, Syst. Nat., Ed. 10, p. 785, 1758; Montfort, Conch. Syst., Vol. 2, p. 23, 1810; Children, Quart. Journ. Sci., Lit., Arts, p. 69, October, 1822; Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, p. xxix, 1897; Henderson, U. S. Nat. Mus., Bull. 111, p. 8, 1920.

Type (by subsequent designation, Montfort, 1810), *Dentalium elephantinum* Linnæus, figured by Pilsbry and Sharp, *op. cit.*, p. 1, pl. 1, figs. 1-7, 1897; Amboyna; Philippine Islands; Recent.

Shell an elongate tube varying from strongly curved to almost straight, open at both ends, and with the maximum diameter at the oral opening; sculptured with longitudinal ribs, which may be faint or strongly developed.

Dentalium neohexagonum Sharp and Pilsbry

"*Dentalium hexagonum* Sowerby," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 612, 648, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 86, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 238, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 194, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 185, 1903; not *Dentalium hexagonum* Gould, Proc. Boston Soc. Nat. Hist., Vol. 7, p. 166, Dec., 1859, Japan, China, etc.

Dentalium neohexagonum Sharp and Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 17, p. 19, pl. 11, figs. 74-86, 1897; Pilsbry, Nautilus, Vol. 17, p. 108, 1904; Dall, U. S. Nat. Mus., Bull. 112, p. 57, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 9, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

"*Dentalium pseudohexagonum* Dall," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 186, pl. 8, figs. 12, 12*a*, 1903.

Shell slender, attenuated and strongly curved toward the apex; sculpture of six strong, projecting ribs, which are much reduced on the larger third of the shell, intercalary riblets low or absent; aperture rounded, hexagonal; anal orifice without notch or slit.

Pliocene: Balboa Park and Pacific Beach, San Diego (Arnold); San Diego well (Cooper).

Pleistocene: Upper and lower San Pedro series of the San Pedro region (Arnold); Barlow's Ranch, near Ventura (Arnold); "Saugus" near Ventura (Waterfall); lower San Pedro of Nob Hill cut (T. S. Oldroyd); at Twenty-sixth Street and at Spanish Bight, San Diego (Arnold); lower Quaternary at Madgalena Bay, and upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to Guacomayo, Central America (Dall, 1921).

The present writers have not seen the true *hexagonum* and do not know whether *neohexagonum* is well distinguished or not.

Dentalium semistriatum Turton variety **semipolitum** Broderip and Sowerby

Dentalium semipolitum Broderip and Sowerby, Zool. Journ., Vol. 4, p. 369, 1829; ? Sowerby, Thes. Conch., Vol. 3, p. 100, pl. 224, fig. 23, 1860; in Reeve's Conch. Icon., Vol. 18, *Dentalium*, pl. 4, fig. 19, 1872; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 238, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 187, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 57, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 10, 1927.

Dentalium hyalinum Philippi, Zeitschr. f. Malak., Vol. 3, p. 55, 1846, not of Carpenter, 1855-7, *fide* Pilsbry and Sharp, 1897.

Dentalium liratum Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 188, 1855-7, young shell, *fide* Pilsbry and Sharp, 1897.
Dentalium lirulatum Mörch, Malak. Blätter, Vol. 7, p. 177, 1861, *fide* Pilsbry and Sharp, 1897.
Dentalium semistriatum Turton, variety *semipolitum* Broderip and Sowerby, Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, pp. 90, 91, pl. 16, fig. 54, 1897.

Pliocene: San Diego well, San Diego (Dall).
Pleistocene: "Rare in upper San Pedro series at San Pedro, Deadman Island, and Crawfish George's," Los Angeles County (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro, California, to Mazatlan, Mexico (Dall, 1921).

This slender shell is marked with very numerous, fine, closely-set, subequal, longitudinal striæ, extending from the apex downward, about two-thirds of the length of the shell, the remaining surface being smooth. There is no notch or slit on the minute, round anal orifice. According to Pilsbry and Sharp, *Dentalium semistriatum* Turton,[1] of the Gulf of Mexico, is not specifically different; and it is probable that *semipolitum* should be considered a synonym.

Dentalium pretiosum Nuttall in Sowerby

"*Dentalium politum* Lamarck," Middendorff, not Lamarck.
Dentalium pretiosum Nutt., Sowerby, Thes. Conch., Vol. 3, p. 95, pl. 225, fig. 57, 1860; Keep, West Coast Shells, p. 113, fig. 101, 1888, 1892; Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, p. 44, pl. 13, figs. 1, 2, 3, 1897; Dall, U. S. Nat. Mus., Bull. 112, p. 57, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 8, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 13, pl. 1, fig. 10, 1927.
Dentalium (var.) *indianorum*, *Dentalium* (? *pretiosum* Nutt., Sby. var.) *indianorum*, *Dentalium indianorum*, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 612, 648, 683, 1864.
Dentalium indianorum Carpenter, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 238, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 186, pl. 8, fig. 4, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908.
Dentalium cf. *pretiosum* Sowerby, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: "Pico" near Ventura (Waterfall, as "*Dentalium* cf. *pretiosum* Sowerby"); upper Pliocene at Bathhouse Beach, Santa Barbara (Berry).
Pleistocene: Lower San Pedro series of San Pedro and Deadman Island (Arnold); lower San Pedro of Nob Hill cut, San Pedro (T. S. Oldroyd); Santa Barbara (Cooper); "Saugus" near Ventura (Waterfall, as "*Dentalium* cf. *pretiosum* Sowerby"); rare in the upper San Pedro at Crawfish George's, San Pedro (Arnold); upper Quaternary at San Ignacio Lagoon, Lower California, Mexico (Jordan).
Recent: Forrester Island, Alaska, to Cedros Island, Lower California, Mexico.

This species lacks longitudinal sculpture, except for striæ near the apex or on young specimens. The orifice at the apex is oblong and extends into a small notch on the convex side. This species is very similar to *Dentalium entalis stimpsoni* Henderson,[2] and belongs to the section *Antalis* H. and A. Adams.

Dentalium rectius Carpenter

Dentalium rectius Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 603, 648, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 59; Newcombe, Nautilus, Vol. 10, p. 18, 1896; Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, p. 114, pl. 21, fig. 45, 1897; Dall, U. S. Nat. Mus., Bull. 112, p. 57, 1921; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 94, 1922; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 11, pl. 1, fig. 3, 1927.
? *Dentalium petricola* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 136, 1909, *fide* Howe, 1922.

? *Miocene:* Miocene of Astoria (Dall, 1909, *fide* Howe, 1922).
Pliocene: Coos conglomerate of Coos Bay, Oregon, and upper Wildcat formation of Humboldt County, California (Howe).
Recent: Stephens Passage, Alaska, to Panama Bay (Dall, 1921).

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[1] Conch. Dict. Brit. Is., p. 39, pl. 18, fig. 68, 1819.

[2] U. S. Nat. Mus., Bull. 111, p. 35, pl. 4, figs. 2, 3, 4, 1920.

This is a long, slender, nearly straight, fragile shell, with a smooth, glossy surface and no notch on the orifice at the slender apical end. It is smaller and less curved than *D. dalli* Sharp and Pilsbry, but is larger and less slender than *D. watsoni* Sharp and Pilsbry. It is the type of the section *Rhabdus* Pilsbry and Sharp, 1897, by original designation.

Family CADULIDAE

(SIPHONODENTALIIDAE)

Shell generally smooth, often inflated; width of median tooth much less than double its length, generally less than the length; foot veneriform, capable of expansion into a terminal or subterminal rosette-like disk, not interrupted dorsally. (Pilsbry and Sharp, 1897.)

This family, generally called *Siphonodentaliidæ*, includes the genera *Cadulus*, *Siphonodentalium*, and *Entalina*. For a discussion of the systematics of these genera the reader is referred to the monograph by Pilsbry and Sharp in Tryon's Manual of Conchology (Series 1, Volume 17) and to a recent monograph on the east American *Scaphopoda* by Henderson (U. S. National Museum, Bulletin 111, 1920), both of which have been used in the arrangement given below.

Genus CADULUS Philippi, 1844

Cadulus Philippi, Enum. Moll. Sicil., Vol. 2, p. 209, 1844; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 150, 1846; Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, pp. 131, 142, 1897; Henderson, U. S. Nat. Mus., Bull. 111, p. 11, 1920.

Type (by subsequent designation, Herrmannsen, 1846),[1] *Cadulus ovulum* Philippi, *op. cit.*, Vol. 2, p. 208, pl. 27, fig. 21, 1844, *fide* Pilsbry and Sharp, *op. cit.*, p. 157, pl. 32, figs. 40, 41, 1897.

Shell more or less swollen near the middle, smooth, polished, circular or oval in cross section, apex simple or with two to four notches or slits.

The genera *Entalina* Monterosato, 1872, and *Siphonodentalium* M. Sars, 1859, contain the members of the *Cadulidæ* which have the shell largest at the aperture. *Entalina* further differs from *Cadulus* in being longitudinally ribbed.

The genus *Cadulus* can be somewhat artificially subdivided into sections as follows:

Apex not slit or notched:

Small obese forms, dorsal and ventral arcs both convex	*Cadulus, s. s.*
Slender forms, one arc convex, the other more or less concave	*Gadilia* Gray[2]
Apex with two prominent slits	*Dischides* Jeffreys[3]
Apex with four prominent slits, leaving four prominent, triangular lobes	*Polyschides* Pilsbry and Sharp[4]
Apex with four very shallow notches, leaving four wide lobes	*Platyschides* Henderson[5]

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[1] Philippi's original description of *Cadulus* has not been available.

[2] Proc. Zool. Soc. London for 1847, p. 159, type *D. gadus*, by original designation.

[3] Ann. Mag. Nat. Hist., Ser. 3, Vol. 20, p. 251, 1867, type *Cadulus politus* S. V. Wood.

[4] Tryon's Man. Conch., Ser. 1, Vol. 17, p. 146, 1897, type, by original designation, *Cadulus* (*Polyschides*) *tetraschistus* Watson, Journ. Linn. Soc. London, Vol. 14, p. 521, 1879.

[5] U. S. Nat. Mus., Bull. 111, p. 104, 1920, type, by original designation, *Cadulus grandis* Verrill, Trans. Conn. Acad. Arts Sci., Vol. 6, p. 219, pl. 44, fig. 20, 1884.

Cadulus fusiformis Pilsbry and Sharp

"*Cadulus fusiformis* Philippi," Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 231, 1888.

Cadulus fusiformis Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, p. 193, pl. 35, fig. 14, 1897; Pilsbry, Nautilus, Vol. 17, p. 108, 1904; Dall, U. S. Nat. Mus., Bull. 112, p. 58, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 15, pl. 1, fig. 4, 1927.

Pliocene: San Diego well, San Diego (Cooper).

Recent: Monterey, California, to Cape San Lucas, Lower California, Mexico (Dall).

This species is only slightly curved and the shell is not much contracted beyond the point of greatest inflation. The apex is simple, rather sharp lipped.

"*Cadulus nitentior* Carpenter" of Arnold (Mem. Calif. Acad. Sci., Vol. 3, p. 187, pl. 8, fig. 15, 1903) is probably a serpuloid annelid, according to Pilsbry (1904). The "*Cadulus fusiformis* Philippi" of Cooper, from the middle Pliocene of the San Diego well, is the present species; but it was a *nomen nudum* until described by Pilsbry and Sharp.

Cadulus hepburni Dall

Cadulus hepburni Dall, Bull. Nat. Hist. Soc. Brit. Columbia, No. 2, p. 12, pl. 1, fig. 13, 1897; Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, p. 194, pl. 35, figs. 19, 20, 1897; Dall, U. S. Nat. Mus., Bull. 112, p. 58, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 15, pl. 1, fig. 13, 1927.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd).

Recent: Victoria, British Columbia, to Monterey, California (Dall, 1921).

This shell is very close to *C. fusiformis*, but is more curved and more constricted at the aperture.

Cadulus tolmiei Dall

Cadulus tolmiei Dall, Bull. Nat. Hist. Soc. Brit. Columbia, No. 2, p. 13, pl. 1, fig. 8, 1897; Pilsbry and Sharp, Tryon's Man. Conch., Ser. 1, Vol. 17, p. 181, pl. 34, figs. 3, 4, 1897; Dall, U. S. Nat. Mus., Bull. 112, p. 58, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 16, pl. 1, fig. 9, 1927.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Vancouver Island, British Columbia, to San Quintin Bay, Lower California, Mexico (Dall, 1921).

This small species is much like *Cadulus rushi* Pilsbry and Sharp, of the Atlantic coast.

Cadulus arcticus Dall

Cadulus arcticus Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 30, pl. 5, fig. 8, 1920.

Pliocene: "Pliocene of Carter Creek, in the Camden Bay region of the Arctic coast, 1 mile from the coast" (Dall).

CLASS GASTROPODA

ORDER PTEROPODA

The pteropods are naked or thin-shelled pelagic mollusks that swim actively by means of fin or wing-like appendages modified from the foot. Species that are protected by a thin, transparent or translucent shell have been placed in the suborder *Thecosomata*, the naked forms being grouped under the *Gymnosomata*. Some of the thick-shelled, elongate, tapering, tubular species of the Paleozoic (the *Conulariidæ*) may not be closely related to the more modern Pteropoda.

Family CLIIDAE

Shell bilaterally symmetrical, thin, glassy, ventricose, shield shaped, pyramidal, or conically tubiform.

Geologic range: Cretaceous to Recent.

As *Clio* is the oldest genus in the family, we have used the name *Cliidæ* in preference to *Cavolinidæ*.

Genus CAVOLINA Abilgaard, 1791

Cavolina Abilgaard, Skrivter af Naturhistorie-Selskabet, Vol. 1, Heft 2, p. 174, 1791; Sykes, Proc. Malac. Soc. London, Vol. 7, p. 5, 1906; Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, no. 6, p. 230, 1908; Suter, Man. New Zealand Moll., p. 53, 1913; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 112, 1928.

Not *Cavolina* Bruguière, Ency. Méth., Vers, pl. 85, 1791, a nudibranch.

Hyalæa Lamarck, "Prodr.," Mém. Soc. Hist. Nat., Paris, Sér. 1, Vol. 1, p. 89, 1799.

Type (by monotypy), *Cavolina natans* Abilgaard = *Monoculus telemus* Linnæus.

Shell globose, composed of two unequally arched pieces, one of which projects helmet-like anteriorly beyond the other, is less convex, and is marked by a few radial grooves or undulations, both pieces coming to a posterior point, often with sharp angles or cusps laterally, which with the central point give the posterior end a tricuspid appearance.

Geologic range: Miocene to Recent.

Geographic distribution: Widespread, pelagic.

Cavolina telemus (Linnæus)

Monoculus telemus Linnæus, Syst. Nat., Ed. 10, p. 635, 1758.

Anomia tridentata Forskål, Descriptiones Animalium Quae in Itinere Orientali Observavit, p. 124, 1773.

Cavolina natans Abilgaard, Skriv. Naturhist.-Selsk., Vol. 1, Heft 2, p. 175, pl. 10, 1791.

Hyalæa tridentata Lamarck, Blainville, Man. Malac., p. 480, pl. 46, fig. 2, 1825; Sowerby, Conch. Man., Ed. 1, p. 52, fig. 226, 1839; Ed. 2, p. 164, fig. 226, 1842; Ed. 3, same p. and fig., 1846; Ed. 4, p. 172, pl. 11, fig. 198, 1852; Rang and Souleyet, Hist. Nat. Moll. Ptéropodée, pp. 35-37, pl. 2, figs. 1-6, pl. 12, figs. 1-4, 1852; Boas, Spolia Atlantica, p. 115, pl. 1, fig. 8, pl. 2, fig. 19, 1886.

Cavolina tridentata Forskål, Verrill, Trans. Conn. Acad. Arts Sci., Vol. 5, p. 554, figs. 6, 7, 1882; Pelseneer, Rept. Voy. Challenger, Zool., Vol. 23, pt. 65, p. 83, 1887.

Cavolina telemus Linnæus, A. Adams, Ann. Mag. Nat. Hist., Ser. 3, Vol. 3, p. 44, 1859; Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, no. 6, pp. 230-234, 1908; Suter, Man. New Zealand Moll., p. 55, pl. 6, fig. 3, 1913; Johnson, Boston Soc. Nat. Hist., Occasional Papers, Vol. 7, p. 156, 1915; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 113, pl. 1, figs. 6, 7, 1928.

Type locality: Mediterranean Sea, Recent.

Geologic range: Miocene to Recent (see below).

This Mediterranean and Atlantic species seems to be very widely distributed. It is likely that a critical study of abundant material would point to a further reduction in the number of forms in this genus that should retain distinctive specific names. Some of the shell differences, particularly differences in size, may be mere reflections of conditions of food supply or temperature, as mentioned by Dall. The north Pacific form listed below is given a separate varietal heading more to segregate the synonymy and references than to emphasize any possible valid distinction from a systematic standpoint.

Cavolina telemus (Linnæus) variety **tricuspida** (Rivers)

Cavolina telemus Linnæus, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 612, 621, 646, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 98, 107, 132 (bottom pagination), 1872.

Hyalæa tricuspida J. J. Rivers, Bull. Southern Calif. Acad. Sci., Vol. 3, no. 5, p. 69, May, 1904.

Cavolina tridentata Forskål, Keep, West American Shells, p. 107, 1904; Revised Ed., p. 127, 1911.

Cavolina occidentalis Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, no. 6, p. 233, pl. 12, figs. 1, 1*b*, 1*c*, October, 1908; U. S. Nat. Mus., Bull. 112, p. 59, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 19, 1927.

Shell opaque white; dorsal plate widely convex; smooth on the disc; a lateral spine on either side and a terminal appendage short and truncate behind; parallel to the lateral spines is a carina; on the disc of the other side are five longitudinally situated carinæ; aperture sharply truncate on dorsum, but strongly rounded on the opposite plate; the slit reaching quite to the lateral spines. Dimensions: Longitude 8 mm., latitude 7 mm. (Rivers.)

Type specimen: Of *occidentalis*, in the U. S. National Museum, No. 110,591.

Type localities: Of *tricuspida*, Santa Monica Mountains, presumably near Santa Monica, Los Angeles County, California, stated to be Pleistocene; of *occidentalis*, northeast Pacific Ocean, between latitudes 30° and 54° North, Recent.

Pleistocene: At the type locality of *tricuspida;* embankment on west shore of Spanish Bight, San Diego Bay, California (Mrs. Kate Stephens, MS.).

Recent: North Pacific to southern California.

Although the form from the Pacific coast of North America may not have sufficient distinguishing characteristics to separate it from the typical form, it has been retained tentatively as a doubtful variety, until more specimens from the Atlantic and Pacific can be carefully compared.[1] Unfortunately Rivers did not figure the shell he named *tricuspida*, and his type is probably lost; but his description does not suggest any means of separating the Pleistocene shell from the Recent. It is very unusual for a Pleistocene shell to differ specifically from its living descendant; and for a pteropod, it would be practically out of the question. Furthermore, the living form is known on good authority to occur rarely in the Pleistocene deposit at North Island, San Diego Bay.

Woodring has reported the Atlantic form, presumably the typical variety, from the Bowden formation, middle Miocene of Jamaica, and also questionably from the Gurabo formation, middle Miocene of the Dominican Republic. The typical form has also been reported as a fossil from several localities in Europe.

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[1] The Pacific variety is said to be on the average smaller in size, with shorter posterior points or spines, but these differences are not likely to be constant or significant.

ORDER OPISTHOBRANCHIATA

(CEPHALASPIDEA)

Family ACTEONIDAE

Shell entirely external and capable of containing the entire animal; spiral, with projecting or depressed spire and moderately numerous whorls, the internal whorl-partitions not absorbed; surface generally sculptured with spiral, punctured grooves; aperture rounded below, with or without columellar folds, provided with an operculum. (Pilsbry in Tryon's Man. Conch.)

This family includes the operculate, opisthobranchiate mollusca which possess a radula, differing in the last feature from the *Retusidæ.* The family includes several genera which date from the Mesozoic or earlier. *Acteonina* d'Orbigny[1] has for its type a species from the Carboniferous of Belgium. *Tornatellæa* Conrad[2] extends back to the Lias, according to Cossmann,[3] and is represented in the lower Eocene of California by "*Cinulia*" *pinguis* Gabb,[4] from the Martinez formation.

Genus ACTEON Montfort, 1810

Acteon Montfort, Conch. Syst., Vol. 2, pp. 314-316, 1810; not *Actæon* Oken, 1815, nor Fleming, 1828.
Tornatella Lamarck, Hist. Anim. s. Vert., Vol. 6, pt. 2, p. 219, 1822.

Type (by monotypy), *Acteon tornatilis* (Gmelin) = *Voluta tornatilis* Gmelin.

Shell compact, with short spire and large, ovate body whorl; aperture over half the length of the shell, narrowed above, the columella bearing a single, simple, spiral fold. (Pilsbry, in Tryon's Man. Conch.)

Geologic range: Cretaceous to Recent.

Distribution: World wide in warm temperate waters.

Solidula Fischer de Waldheim, the type of which is *Voluta solidula* Linnæus, differs from *Acteon* in having the columellar fold very much heavier, typically bifid above, the deep groove being sometimes bordered by a small plait on the upper side.

Subgenus **ACTEON**, s. s.

Columella merging gradually into the regularly rounded basal lip.

Acteon (Acteon) traski Stearns

Actæon traski Stearns, Nautilus, Vol. 11, p. 14, 1897; Proc. U. S. Nat. Mus., Vol. 21, p. 297, text figure, 1899; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 188, pl. 10, fig. 6, 1903.
Acteon traski Stearns, T. S. Oldroyd, Nautilus, Vol. 28, p. 81, 1914; Dall, Bull. 112, U. S. Nat. Mus., p. 60, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 24, pl. 1, fig. 12, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Spanish Bight, San Diego, California; Pleistocene.

Pleistocene: Upper San Pedro series at San Pedro (Arnold); of Signal Hill, Long Beach, and Santa Monica, Los Angeles County (T. S. Oldroyd, coll.); Pleistocene of Spanish Bight (Stearns); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan).
Recent: Catalina Island, California, to Panama (A. M. Strong).

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[1] Prod. Paleo. Anim. Moll., Ray, 1849, *fide* Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 433, 1927.

[2] Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 4, p. 294, 1860, monotype, *T. bella* Conrad, *op. cit.*, pl. 47, fig. 23.

[3] Ess. Paléo. Comp., Vol. 1, p. 49, 1895.

[4] *Fide* Stewart, *op. cit.*, p. 433.

This species is readily distinguished from the other described Pacific coast Pleistocene species by subgeneric characters. It is about the size of large specimens of *A. punctocælatus* (about 15 mm. in length), but has five post-nuclear whorls (including the body whorl) instead of four.

Subgenus **RICTAXIS** Dall, 1871

Rictaxis Dall, Amer. Journ. Conch., Vol. 7, p. 136, pl. 15, fig. 12, 1871; Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 236, 1908.

Actæonidea Gabb, Proc. Acad. Nat. Sci. Phila. for 1872, p. 273, pl. 11, figs. 8, 8A, Feb. 1873, monotype *A. oryza* Gabb.

Type (by monotypy), *Tornatella punctocælata* Carpenter.

Like *Acteon, s. s.*, but with the columella projecting anteriorly or truncate obliquely.

Acteon (**Rictaxis**) **punctocælatus** (Carpenter)

Tornatella punctocælata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 646, 1864; Journ. Conchyl., Vol. 12, p. 139, 1865; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 267, 1888.

Rictaxis punctocoelata Carpenter, Dall, Amer. Journ. Conch., Vol. 7, p. 136, pl. 15, fig. 12, 1871; Tryon, Struc. Syst. Conch., Vol. 2, p. 356, pl. 87, fig. 28, 1883.

Rhextaxis punctocoelata Carpenter, Keep, West Coast Shells, p. 125, fig. 115, 1888; 1892.

Actæon punctocælatus Carpenter, Pilsbry, in Tryon, Man. Conch., Vol. 15, p. 166, pl. 49, figs. 24, 1893; Stearns, Nautilus, Vol. 11, p. 15, 1897; Proc. U. S. Nat. Mus., Vol. 21, p. 298, 1899.

Actæon punctocoelatus var. *coronadoensis*, Stearns, Proc. U. S. Nat. Mus., Vol. 21, p. 299, 1898.

Actæon (*Rictaxis*) *punctocoelata* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 189, pl. 9, fig. 6, 1903.

Acteon punctocælatus Carpenter, T. S. Oldroyd, Nautilus, Vol. 28, p. 81, 1914.

Acteon (*Rictaxis*) *punctocoelata* Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 60, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, pp. 24, 25, pl. 1, figs. 17, 17*a*, 1927.

Acteon punctocoelatus Carpenter, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925.

Acteon punctocoelata Carpenter, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Acteon punctocoelatus vancouverensis I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 25, pl. 1, figs. 19, 20, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Santa Cruz ?, California.

Pleistocene: (As *A. punctocælatus*): Lower San Pedro of Deadman Island and San Pedro; upper San Pedro at San Pedro; Pleistocene of Spanish Bight, San Diego (Arnold); lower San Pedro at Nob Hill, San Pedro (T. S. Oldroyd); upper San Pedro at Signal Hill and at Santa Monica (T. S. Oldroyd collection); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926). (As *A. punctocælatus* var. *coronadoensis*): Pleistocene of Spanish Bight, San Diego (Stearns); upper San Pedro at Signal Hill and at Santa Monica, Los Angeles County (Oldroyd Collection). (As *A. punctocælatus vancouverensis*): Upper San Pedro at Signal Hill and at Santa Monica (Oldroyd Collection).

Recent: Monterey, California, to Magdalena Bay, Lower California, Mexico (Dall, 1921).

Carpenter described this species briefly in the British Association Report for 1863, and later more adequately in the Journal de Conchyliologie for April, 1865. The dimensions given are "Long. .2, long. spir. .06, lat. .09, poll.; div. 50°." Specimens that are generally classified as *A. punctocælatus* Carpenter from San Pedro are very much larger than Carpenter's measurements indicate. Specimens in the Oldroyd Collection at Stanford University are relatively enormous, the largest being three-quarters of an inch (about 20 mm.) in axial length. Stearns described as the variety *coronadoensis* elongate specimens collected from the Pleistocene deposit at Spanish Bight, San Diego, which had lost the color markings. In the Oldroyd Collection there are Recent specimens from La Jolla labeled *coronadoensis*, some of which seem to fit Stearns' brief description. Some do not have the "broad dark bands," while others do. They are "attenuated and delicate" and range in size from about 6 mm. to 9 mm. in axial length. The smallest is larger than

Carpenter's type. Specimens from Vancouver Island average smaller than the large San Pedro shells. This smaller shell has been named *vancouverensis*. It appears to be a degenerate or impoverished race, but as specimens that are apparently identical occur with the large form in the upper San Pedro deposits of Signal Hill and San Pedro, it cannot be considered a geographic race. The variety *coronadoensis* also appears to occur in the Pleistocene deposits of Signal Hill (Oldroyd Collection). Therefore it appears that these so-called varieties are not based upon valid distinctions. The large San Pedro Recent specimens would be the most distinct from Carpenter's *punctocœlatus*, if size were used as a basis of separation.

Acteon painei Dall is a wider, lower spired form described from a station off Catalina Island.

Acteon (Rictaxis) painei Dall

Acteon painei Dall, Proc. Biol. Soc. Wash., Vol. 16, p. 172, 1903; Bull. 112, U. S. Nat. Mus., p. 60, pl. 3, fig. 5, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, pp. 25, 26, pl. 1, fig. 18, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Near Avalon, Catalina Island, California.

Recent: Off Catalina Island, in 50 fathoms (Dall).

This species differs from *A. punctocœlatus* by being relatively much broader, with a lower spire. The type was described as having a length of 8 mm. and a breadth of 5 mm.

Acteon (Rictaxis) painei Dall, variety **grandior,** new variety

Plate 24, Figure 12

Shell like that of typical *painei* but more cylindrical in shape and about twice as large. Dimensions: Length, 18 mm., slightly imperfect, complete length probably about 19 mm.; diameter, 10.5 mm.

Type specimen: San Diego Society of Natural History, No. 208.

Type locality: Holser Canyon, Los Angeles County; middle Pliocene.

Pliocene: At the type locality.

The new variety *grandior* has a more nearly cylindrical body whorl than the typical variety of *painei*. The profile of the body whorl of the fossil is nearly straight to a point near the base where it curves in more suddenly than on the typical form. Both shells have about twenty-three flat, strap-like, spiral ribs separated by punctate interspaces. The fossil variety is decidedly larger than the living variety.

Family RETUSIDAE

(ACTEOCINIDAE)

Shell spiral, cylindrical, or fusiform, external, capable of containing the soft parts; spire short or sunken and concealed, the apex more or less oblique to the shell axis; aperture long and narrow, wider below; columella simple or with a fold; umbilicus none or very narrow. Animal with the foot shorter than the shell, entire behind; headshield short, quadrangular, produced in two erected processes behind, near the bases of which are the eyes. Radula-teeth wanting; gizzard armed with three oval, tuberculate plates. (Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 5, p. 180, 1893, description of *Acteocinidæ*, altered.)

This family differs from the *Acteonidæ* in the lack of the operculum and the radula. Pilsbry and others have pointed out that it is difficult to place some of the species in the proper genera by the use of shell characters, but several authors have stated that the anatomy is distinctive and significant.

The name *Retusidæ* is used here in preference to *Acteocinidæ* because *Retusa* is an older name than *Acteocina* and because the conchological differences between the two groups are small and so variable that they do not appear to be of full generic significance. The International Commission on Zoological Nomenclature has not formulated any inflexible rules applying to family names, but it seems advisable to base the family names on the oldest valid generic name. *Acteocina* is here considered as a subgenus of *Retusa*.

In the Pleistocene and Recent faunas of the Pacific coast there are a number of species of the *Retusidæ*, most of which are not well known. The shells are rather variable, and until the anatomy of the animals is known and can be correlated with shell characters, some of the confusion which has occurred in this group is apt to continue. Misidentifications have been made, because many of the types have not been available, and what figures there are in the literature are not always helpful or reliable.

For a discussion of the ranges of some of the Recent Pacific coast species, the reader is referred to papers by A. M. Strong and W. H. Dall.[1]

Genus RETUSA Brown, 1827

Retusa Brown, Illust. Conch. Gr. Brit. Irel., pl. 38, figs. 1-6, 1827; Pilsbry in Tryon's Man. Conch., Ser. 1, Vol. 15, pp. 203, 204, 1893; Sykes, Proc. Malac. Soc. London, Vol. 6, p. 31, 1904; Iredale, Vol. 11, p. 300, 1915; Woodring, Carnegie Inst., Publ. No. 385, p. 119, and footnote, 1928.

Utriculus Brown (in part), Illust. Conch. Gr. Brit. Irel., Ed. 2, p. 58, 1844; not of Schumacher, 1817, (*Conidæ*).

? *Tornatina* A. Adams, in Sowerby, Thes. Conch., Vol. 2, p. 554, 1850.

Type (see below), *Bulla obtusa* Montagu (= ? *plicata* Brown = ? *discors* Brown, = ? *Voluta alba* Kanmacher, *fide* Iredale, 1915, and Woodring, 1928); figured by Montagu, Test. Brit., pl. 7, fig. 3, 1803.

Although there has been some uncertainty in regard to the genotype of *Retusa*, the three supposedly different species originally included in the genus by Brown are apparently all congeneric, and hence the definition of the genus is clear. "*Bulla*" *obtusa*, the type of *Retusa*, is a small, somewhat cylindrical shell without a columellar plication and with a small spire which varies considerably in height and may even be truncated, the apex sometimes turned inwards. Jeffreys[2] has given an excellent description of the species.

Subgenus **RETUSA**, s. s.

Columella without plications; inner lip incrusted with callus, which may be sharply delimited; umbilicus closed or a mere chink.

Retusa obtusa (Montagu), the type of *Retusa*, is circumboreal and has been reported by Dall to range from the Arctic Ocean to St. Matthew Island. *Retusa semen* (Reeve) has a depressed spire, but belongs in *Retusa, s. s.*, rather than in *Coleophysis*. *R. pertenuis* (Mighels), which occurs in Bering Sea, is a typical *Retusa*. *Acteocina smirna* Dall, of the Lower California coast, is very close to *R. recta* (d'Orbigny). These two latter species have an obscure fold on the columella and illustrate the close relationship between *Retusa* and *Acteocina*. *Retusa harpa* (Dall) has the fine axial sculpture of *Coleophysis*

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[1] A. M. Strong, Nautilus, Vol. 35, pp. 44-48, Oct., 1921;
W. H. Dall., Nautilus, Vol. 35, p. 96, Jan., 1922;
A. M. Strong, Nautilus, Vol. 35, pp. 122-123, April, 1922.

[2] Jeffreys, Brit. Conch., Vol. 4, pp. 423, 424, 1867; description reproduced and figure supplied by Pilsbry in Tryon's Man. Conch., Vol. 15, pp. 214, 215, pl. 23, fig. 51, 1893.

Fischer,[1] but the type of the latter has an involute spire, the outer lip extending the entire length of the shell. *Retusa xystrum* (Dall), which ranges from San Pedro to San Diego, belongs in the section *Sulcularia* Dall.[2] This section is very close to *Coleophysis* Fischer, but it has an apical perforation and no plication on the columella. The types of both *Coleophysis* and *Sulcularia* have fine axial sculpture, but the former has a very small fold or plication which is entirely absent on *Sulcularia*. *Retusa xystrum* (Dall)[3] has fine axial striæ. It is a very delicate, small shell, about 2 or 3 mm. in length.

Retusa (Retusa) harpa (Dall)

Tornatina harpa Dall, Amer. Journ. Conch., Vol. 7, p. 136, pl. 15, fig. 11, 1871; Keep, West Coast Shells, p. 125, 1888, 1892; Pilsbry, in Tryon's Man. Conch., Vol. 15, p. 186, pl. 22, fig. 16, 1893; Newcombe, Nautilus, Vol. 10, no. 2, pp. 17, 19, 1896; Baker, Nautilus, Vol. 16, p. 42, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 191, 1903.

Retusa harpa Dall, Bull. 112, U. S. Nat. Mus., p. 61, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 33, pl. 2, fig. 3, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Monterey, California; Recent.

Pleistocene: Rare in upper and lower San Pedro series at San Pedro, California (Arnold, 1903); "not rare" in lower San Pedro fauna at Nob Hill, San Pedro (T. S. Oldroyd, 1925).

Recent: Queen Charlotte Islands, British Columbia, to San Diego (Dall).

This species has axial ribs on the upper portion of the body whorl and on the penultimate whorl. The whorls of the spire appear tabulate, and the nucleus is prominent and turned at an angle to the shell axis. Mature specimens range between 3 and 7 mm. in axial length.

The shape and the smooth columella of this species are as in *Retusa*, *s. s.*, but the prominent, protruding nucleus and the well-developed axial sculpture suggest that it may belong elsewhere. It cannot belong in *Coleophysis*, as the type of that section has a shell with an involute spire.

Subgenus **ACTEOCINA** Gray, 1847

Acteocina Gray, Proc. Zool. Soc. London for 1847, p. 160, 1847.

Type (by original designation), *Acteon wetherilli* Lea, Miocene of New Jersey.[4]

Shell small or medium sized, cylindrical, spire low, suture channeled; nuclear whorls small, papillate, more or less submerged, coiled at an angle of about 90° to axis of post-nuclear whorls; aperture long, narrow, dilated, and rounded at anterior end; columella bearing an oblique basal fold emerging from aperture and merging into basal lip; sculpture absent or consisting of faint spiral grooves. (Woodring, Carnegie Inst. Publ., No. 385, p. 119, 1928.)

According to Woodring,[5] the earliest American species of this genus is from the upper Oligocene Byram marl. The "*Acteocina*" *chehalisensis* Weaver,[6] of the "*Molopophorus lincolnensis* zone" of Washington (lower or middle Oligocene), is an *Acteon*, and belongs in the preceding family.

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[1] Man. Conchyl., p. 555, Dec. 20, 1883, type (by monotypy), *Utriculus truncatulus* Bruguière; Recent, European seas.

[2] U. S. Nat. Mus., Bull. 112, pp. 61, 202, Feb. 24, 1921, type, by original designation (p. 202), *Retusa sulcata* (d'Orbigny) = "*Bulla*" *sulcata* d'Orbigny.

[3] Proc. U. S. Nat. Mus., Vol. 56, p. 297, 1919.

[4] *Acteon wetherilli* Lea, Contr. Geol., p. 213, pl. 6, fig. 224, 1833; said to be related to or identical with *T. recta* Gabb (as of d'Orbigny), *fide* Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 1, p. 15, 1890.

[5] Carnegie Inst., Publ. No. 385, p. 119, 1928.

[6] Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 55, pl. 4, figs. 55, 56, 1916.

Retusa (Acteocina) culcitella (Gould)

Plate 24, Figure 13

Bulla (*Akera*) *culcitella* Gould, Boston Journ. Nat. Hist., Vol. 6, no. 3, pp. 377, 378, pl. 14, fig. 8, Oct., 1853.

Bulla (*Tornatina*) *cerealis* Gould, Boston Journ. Nat. Hist., Vol. 6, p. 378, pl. 14, fig. 9, Oct., 1853.

Tornatina culcitella Gould, Carpenter, Proc. Zool. Soc. London for 1856, p. 227, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, p. 646, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 88, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 268, 1888; Keep, West Coast Shells, p. 125, fig. 114, 1888; 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 195, 1892; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 189, pl. 50, fig. 38, 1893; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 190, pl. 10, fig. 3, 1903.

Tornatina cerealis Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 647, 1864; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 267, 1888; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 188, pl. 5, figs. 39, 40, 1893; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 189, pl. 10, fig. 5, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; Dall, Bull. 112, U. S. Nat. Mus., p. 202, 1921.

Acteocina culcitella Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 61, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 149, 155, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 27, pl. 2, figs. 1*a*, 1*b*, 1*c*, 1927.

Shell large, almost cylindrical; spire low, conical, of about three whorls; suture deep, appearing channeled; aperture long, narrow above, rounded and ample below; outer lip simple, sharp, outline of margin convex anteriorly; columellar fold prominent; sculpture consisting of microscopic spiral striæ and minute, broadly-curved growth lines; color white, generally shaded with fine, closely-spaced brown lines. Size, ranging up to 22 mm. in axial length and 9 mm. in width of body whorl.

Type locality: Santa Barbara, California; Recent.

Pliocene: Upper Pliocene at Bath-house Beach, Santa Barbara (Arnold, 1903; Berry, 1908, the latter as *cerealis*).

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (E. K. Jordan, 1924); lower San Pedro series at San Pedro and vicinity (Arnold, 1903; T. S. Oldroyd); Pleistocene at Barlow's Ranch, near Ventura (Arnold); lower Pleistocene at Harmon Canyon, Ventura Co., Calif. (S. D. S. N. H. loc. 236, U. S. G., collector); mouth of Elk River, Oregon (Arnold and Hannibal, collectors); upper San Pedro series at San Pedro and vicinity (Arnold, 1903; T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926); Pleistocene at Twenty-sixth street and Spanish Bight, San Diego (Arnold, 1903; Mrs. K. Stephens); upper San Pedro Pleistocene at Signal Hill (T. S. Oldroyd); upper San Pedro Pleistocene at Santa Monica (F. C. Clark, T. S. Oldroyd, collectors); Pleistocene north of Arroyo Santa Rosa, Ventura County (S. D. S. N. H. loc. 233, U. S. G., collector).

Recent: Alaska to Scammons Lagoon, Lower California, Mexico (E. K. Jordan, 1924).

This species is quite variable in size. Until recently, small specimens have been called *cerealis* Gould. Large specimens with the anterior portion of the shell larger than the posterior have been separated as a distinct species. The spire of this latter form is quite low and has a recognizably different appearance. As it may represent an incipient new subspecies, we have regarded its name as of varietal standing (*A. culcitella* var. *pedroensis* T. S. Oldroyd). Mr. Willett has separated the form with no excavation at the apex and with a very weak or obsolete columellar fold as sub-species *intermedia*.[1]

The single specimen upon which the Harmon Canyon lower Pleistocene record is based is large and shaped somewhat like variety *pedroensis* Oldroyd; but as the spire is lacking and it is somewhat intermediate in shape, we have applied to it the older name.

Acteocina eximia Baird is closely related, but the spire is in an excavation at the apex of the shell. Mr. George Willett of the Los Angeles Museum, a careful worker on Recent shells, considers[2] *eximia* a subspecies of *culcitella*.

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[1] Nautilus, Vol. 42, no. 2, p. 38, Oct., 1928; type in Los Angeles County Museum; type locality, Catalina Island, in 30 fathoms.

[2] Nautilus, Vol. 42, p. 37, 1928.

Retusa (Acteocina) culcitella (Gould) variety **pedroensis** (T. S. Oldroyd)

Acteocina pedroensis T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, pp. 23, 24, pl. 2, fig. 9, 1925.

Type specimen: In the U. S. National Museum.

Type locality: Nob Hill, San Pedro, Los Angeles Co., California; lower San Pedro series, Pleistocene.

Pleistocene: Lower San Pedro fauna of Nob Hill, San Pedro, California (T. S. Oldroyd, 1925).

This is a large form with the anterior portion somewhat larger than the posterior. The spire is quite low and the columellar fold well developed. The distinction is of doubtful value.

Retusa (Acteocina) culcitella (Gould) variety **eximia** (Baird)

Tornatina eximia Baird, Proc. Zool. Soc. London for 1863, p. 67, 1863; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 647, 1864; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 268, 1888; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 189 (no figure), 1893; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 190, pl. 10, fig. 11, 1903; E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2, (p. 42), 1919.

Acteocina eximia Baird, Dall, Bull. 112, U. S. Nat. Mus., p. 61, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 28, pl. 2, fig. 6, 1927.

Acteocina culcitella eximia Baird, Willett, Nautilus, Vol. 42, p. 37, 1928.

Type specimen: In the British Museum.

Type locality: Esquimalt Harbor, Vancouver Island, Recent.

Pliocene: San Diego well, Balboa Park, San Diego (Cooper).

Pleistocene: "Pliocene" of Deadman Island, Los Angeles County (Arnold); lower San Pedro of Nob Hill, San Pedro (Oldroyd, 1925); San Diego Pleistocene (Cooper); Pleistocene of the Chiton bed, Point Firmin, Los Angeles County (E. P. and E. M. Chace).

Recent: Kodiak Island, Alaska, to Puget Sound (Dall, 1921).

This species differs from typical *culcitella* in its lower spire, which is set in a circular depression just within the upper margin of the body whorl, in its longer aperture, and in its less prominent columellar fold. The variety *intermedia* Willett does not have the excavation at the base of the spire. We have seen no specimens of *eximia* as large as some specimens of *culcitella*.

Retusa (Acteocina) angustior (Baker and Hanna)

Acteocina angustior Baker and Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 124, pl. 4, fig. 5, April, 1927; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, pp. 142, 147, April, 1927.

Type specimen: In the California Academy of Sciences.

Type locality: Puerto Escondido, Lower California, Mexico; Recent.

Pliocene: Marquer Bay, Carmen Island, Gulf of California, Mexico (Hanna and Hertlein, 1927).

Recent: Gulf of California, Mexico (Baker and Hanna).

This form is distinguished from *A. culcitella* (Gould) by the more cylindric shape and smaller size. The type has a length of 5.4 mm., and a diameter of 2.0 mm.

Retusa (Acteocina) infrequens (C. B. Adams)

Bulla (Tornatina) infrequens C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., Vol. 5, p. 214 (pagination of separate), 1852; Carpenter, Proc. Zool. Soc. London, p. 358, June, 1863.

? *Bulla (Tornatina) gracilis* Menke, Zeitschr. Mal., 1850, p. 162, not of Adams, *fide* Pilsbry, 1893.

Tornatina infrequens C. B. Adams, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 250, 1857; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 171, 1857; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 668, 1864; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 187 (no figure), 1893.

Acteocina infrequens C. B. Adams, Dall, Bull. 112, U. S. Nat. Mus., p. 64, 1921; Strong, Nautilus, Vol. 35, p. 123, 1922; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 29, 1927.

Type specimen: At Amherst College, Massachusetts.

Type locality: Panama.

Pleistocene: Lower San Pedro at Nob Hill, San Pedro ("not rare," T. S. Oldroyd, 1925); Pleistocene at Santa Monica (Dall, erroneously as Recent, see Nautilus, Vol. 35, p. 96, 1922).
Recent: Cape San Lucas, Lower California, Mexico, to Panama (Strong, 1922); Scammons Lagoon, Lower California (Oldroyd Collection).

This is a Panama species, extending north to Cape San Lucas. In the Oldroyd Collection at Stanford University there are fifteen specimens of *infrequens* collected by Henry Hemphill in Scammons Lagoon. These are apparently Recent specimens, which thus extend the known living range northward.

"*T. infrequens* is distinguished by the Oliva-like spire, more or less elevated and deeply channeled along the suture. The body whorl is not swollen anteriorly, and the fold lies slanting on its base. Long. .14, long. spir. .03, lat. .05 [inch]." (Carpenter, Maz. Cat., p. 171.)

Retusa (Acteocina) carinata (Carpenter)

Tornatina carinata Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 171, 1857; Brit. Assn. Adv. Sci., Rept. for 1856, pp. 250, 313, 1857; Rept. for 1863, pp. 551, 647, 1864; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 187, 1893; T. S. Oldroyd, Nautilus, Vol. 28, p. 81, 1914; Zetek, Moll. Panama, p. 521, 1918.
Acteocina carinata Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 61, 1921; Strong, Nautilus, Vol. 35, p. 122, 1922; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 30, 1927.

Smaller than *infrequens*, with the suture not channeled, and the shoulder sharply carinated.

Type specimen: In the British Museum.

Type locality: Mazatlan.

Pleistocene: Upper San Pedro at Signal Hill, Los Angeles County (T. S. Oldroyd); upper San Pedro at Santa Monica, Los Angeles County (Oldroyd Collection); upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926).
Recent: San Diego to Mazatlan.

Retusa (Acteocina) tumida (T. S. Oldroyd)

Tornatina tumida T. S. Oldroyd, Nautilus, Vol. 34, no. 4, p. 116, pl. 5, fig. 8, April, 1921.
Acteocina tumida T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925.

Type specimen: In the U. S. National Museum.

Type locality: Nob Hill, San Pedro, Los Angeles County, California; lower Pleistocene.

Pleistocene: Lower San Pedro series at Nob Hill, San Pedro (T. S. Oldroyd).

This small species is characterized by the effuse anterior portion of the aperture. It is described as having a strong columellar plication, which places it in *Acteocina*. It has been reported only from the lower Pleistocene of Nob Hill (now removed) at San Pedro, California.

Genus VOLVULELLA Newton, 1891

Volvula A. Adams, in Sowerby, Thes. Conch., Vol. 2, p. 558, 1850; Bucquoy, Dautzenberg, and Dollfus, Moll. Roussillon, Vol. 1, pt. 13, p. 533, 1886, type *Volvula rostrata* A. Adams, Recent of Australia, *fide* Woodring, Carnegie Inst., Publ. No. 385, p. 125, 1928; not *Volvulus* Oken, 1815, nor Brullé, 1835, Coleoptera; not *Volvula* Gistel, Naturg. Thierr. Höhere Schulen., p. VIII, 1848, Diptera.

Volvulella R. B. Newton, Syst. List. Edwards Coll. Brit. Olig. Eoc. Moll. Brit. Mus., p. 268, 1891, new name for *Volvula* A. Adams.

Type (by subsequent designation, Bucquoy, Dautzenberg, and Dollfus, 1886), *Volvula rostrata* A. Adams; Recent, Australia.

Geologic range: Eocene to Recent.

Distribution: Widespread in warm and temperate waters.

This genus is characterized in general by the thin, spindle-shaped shell, the concealed spire, and the posterior spine. The anterior end of the aperture is dilated, the columella bearing a faint fold.

Volvulella cylindrica (Carpenter)

Volvula cylindrica Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 647, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 380, 1865; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 270, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 195, 1892; Pilsbry, in Tryon's Man. Conch., Vol. 15, p. 239, unfigured, 1893; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 191, pl. 4, fig. 2, 1903; T. S. Oldroyd, Nautilus, Vol. 28, p. 81, 1914; not *Volvula cylindrica* Gabb, Trans. Amer. Phil. Soc., N. S., Vol. 15, p. 246, 1873, Miocene to Recent, Caribbean, = *Volvula oxytata* Bush.

Volvulella cylindrica Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 62, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 34, pl. 2, fig. 9, 1927.

Type specimen: In the Boyce Collection (*fide* Oldroyd, 1927).

Type locality: Santa Barbara, California.

Pleistocene: Lower San Pedro at Deadman Island (Arnold, 1903); upper Pleistocene of Signal Hill (T. S. Oldroyd, 1914); Pleistocene of the lumber yard at San Pedro, upper Pleistocene at Santa Monica, California (in the collection of T. S. Oldroyd); Pleistocene at 26th St., San Diego (Arnold, 1903).
Recent: Vancouver Island to Gulf of California.

This species differs from *V. cooperi* Dall in the more produced posterior spine and the more prominent axial striæ and growth lines. The spiral striæ are very faint and are apt to be invisible or may be destroyed on many specimens.

Volvulella cooperi Dall

Volvulella cooperi Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 297, 1919; Dall, Bull. 112, U. S. Nat. Mus., p. 62, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 34, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Scammons Lagoon, Lower California, Mexico.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, California (T. S. Oldroyd, 1925, "not rare").
Recent: Point Sur, California, to Scammons Lagoon, Lower California, Mexico (Dall, 1921).

This species is very close to *cylindrica* but has a much less pronounced posterior spine, which in the adult may be entirely lacking. It was described as having an entirely smooth surface. The type measured 9.5 mm. in length by 3.6 mm. in diameter.

V. californica Dall[1] is an elongate-ovate species and is distinguishable by shape from *V. cylindrica* and *V. cooperi*, which are cylindrical. *V. panamica*, *catharia*, and *callicera* were described by Dall[2] from tropical waters. They apparently do not reach California.

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[1] Proc. U. S. Nat. Mus., Vol. 56, p. 298, 1919, type locality, off Santa Rosa Island, California.

[2] Proc. U. S. Nat. Mus., Vol. 56, pp. 298, 299, 1919.

Family SCAPHANDRIDAE

Shell spiral, external, the spire sunken or concealed. Animal with a short subquadrate foot, truncated or forked behind; frontal disc without tentacles, the posterior lobes obsolete; epipodial lobes well developed. Radula having the central tooth small, with a very large lateral on each side of it, and either a few smaller uncini or none. Gizzard containing three calcareous plates, which are not tuberculate. (Pilsbry in Tryon, 1893.)

According to Pilsbry[1] "This family differs from *Tornatinidæ* [*Retusidæ* of the present paper] in the obsolescence of posterior lobes on the head-shield, in the well-developed radula, and the large lateral epipodial lobes. It differs from *Bullidæ* in the highly specialized form of the radula-teeth and their small number in a transverse row." The classification of this family and of the genera assigned to it depends almost entirely on the anatomy of the animal.

Genus SCAPHANDER Montfort, 1810

Bulla Linnæus, Syst. Nat., Ed. 10, p. 725, 1758, not *Bulla* Linnæus, *op. cit.*, p. 427; type cited by Children, Quarterly Journ. Sci., Lit., Arts, Vol. 15, p. 232, July, 1823, *Bulla lignaria* Linnæus.

Scaphander Montfort, Conchyl. Syst., Vol. 2, p. 335, 1810.

Bullaria Rafinesque, Specchio delle Scienze o Giornale Enciclopedico di Sicilia, Vol. 2, no. 11, p. 142, Nov. 1, 1814; reprinted by Binney and Tryon in Complete Writings C. S. Rafinesque on Rec. Fos. Conch., p. 17, New York, 1864, new name for *Bulla* Linnæus.

Assula Schumacher, Ess. Nouv. Syst. Hab. Vers Test., pp. 78, 258, 1817, monotype, *Bulla lignaria* Linnæus.

Type (by original designation), *Bulla lignaria* Linnæus, Recent, eastern north Atlantic and Mediterranean.

Shell external, ovate, imperforate, reaching a large size; spire involute, apical perforation shallow, closed by a callus; aperture large, wide, anterior part broadly expanded; inner lip closely appressed; parietal wall covered with callus; sculpture consisting of narrow spiral grooves (Woodring, Carnegie Inst., Publ. No. 385, p. 126, 1928).

Geologic range: Eocene to Recent.

Distribution: Wide.

The above synonymy may require some explanation. In the tenth edition of the Systema Naturæ, *Bulla* is used by Linnæus for two different groups of animals. On page 427 *Bulla* is used as a subgeneric name for a group of crickets (*Gryllus*), and on page 725 *Bulla* is again used but this time for a group of opisthobranch mollusks. Page priority would favor the use of *Bulla* in entomology to the exclusion of the second *Bulla*, and the first reviser of the generic nomenclature, who appears to have been Rafinesque, chose to relinquish the use of *Bulla* for mollusca, proposing the new name, *Bullaria*, to take its place. No type was stated at that time; but in 1823 Children cited *Bulla lignaria* Linnæus as the type of *Bulla* Linnæus, making *Bulla lignaria* automatically the type of *Bullaria* also. As this species had been used in 1810 as the type of *Scaphander*, and in 1817 as the type of *Assula*, the two later generic names must be considered exact synonyms of Montfort's.

Fossil species of *Scaphander* may not always be readily assigned to the proper genus, unless well-preserved specimens are available. *Atys* Montfort[2] has a fold on the columella, and the aperture projects over the vertex of the shell as a fold, in a manner somewhat similar to the manner in which the columellar fold projects above the apex of the body whorl. There are usually spiral striations on the shell, and typically a small umbilicus is present. *Bullus* Montfort differs from *Scaphander* in having a perforate apex. *Haminoea*

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[1] Pilsbry, in Tryon, Man. Conch., Ser. 1, Vol. 15, p. 242, 1893.

[2] Conchyl. Syst., Vol. 2, p. 343, 1810; type designated, *A. cymbulus* = *Bulla naucum* Linnæus.

Turton and Kingston differs from *Scaphander* in having a much thinner, more delicate shell and in having the outer lip join the apex of the body whorl around a small depressed point, whereas in *Scaphander* the vertex is a concave area closed with callus.

Very few species of *Scaphander* have been reported from the Tertiary of the Pacific coast. "*Cylichna*" *costata* Gabb[1] is an Eocene *Scaphander*, and *Scaphander washingtonensis* Weaver[2] occurs in the Lincoln horizon of the Oligocene of Washington. The Miocene has yielded three species.

Scaphander jugularis (Conrad)

Bulla jugularis Conrad, U. S. House of Representatives, Doc. 129, p. 19, July, 1855; U. S. Pacific R. R. Repts., Vol. 5, p. 328, pl. 7, figs. 62, 62*a*, 62*b*, 1856; reprinted without figures by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 170 (comments also on p. 22), 1909.

Scaphander juguloris Conrad, Anderson, Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, no. 2, p. 201, pl. 15, figs. 56, 57, 1905.

Type locality: Miocene of Ocoya Creek, California.

Miocene: Temblor formation (middle Miocene) of Kern River district, California.

Conrad's original description and figure are hardly adequate to define the species, but F. M. Anderson described and figured *Scaphander jugularis* (Conrad) from the same region and probably the same beds. The species figured by Anderson is apparently a *Scaphander* and not an *Atys*, if the figure can be relied upon.

Scaphander conradi Dall

Scaphander conradi Dall, U. S. Geol. Surv., Prof. Paper 59, p. 22, pl. 6, fig. 3, April 2, 1909.

Type specimen: In the U. S. National Museum.

Type locality: Coos Bay, Oregon; Empire formation, U. Miocene.

This appears to be a typical *Scaphander*. It has a "shorter and more broadly pyriform profile" than *S. jugularis* (Conrad).

Scaphander oregonensis Dall

Scaphander oregonensis Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 22, 23, pl. 5, fig. 7, April 2, 1909; Howe, Univ. Calif. Publ. Geol., Vol. 14, table opp. p. 93, 1922.

Longer and narrower than *S. conradi* Dall.

Type specimen: In the U. S. National Museum.

Type locality: Coos Bay, Oregon; Empire formation, U. Miocene.

Miocene: Empire formation, upper Miocene of Coos Bay, Oregon.
Upper Pliocene (or Pleistocene); Coos conglomerate, Oregon (Howe, 1922).

Genus CYLICHNA Lovén, 1846

Bullina Risso, Hist. Nat. Europe Mérid., Vol. 4, p. 51, 1826, not *Bullina* Férussac, 1822.

Cylindrella Swainson, Treat. Malac., pp. 135, 326, 1840, type *C. alba* Sw., not *Cylindrella* Swainson, *op. cit.*, p. 311, nor *Cylindrella* Pfeiffer, Wiegman's Archiv f. Naturg., Vol. 1, p. 38, 1840.

Cylichna Lovén, Index Moll. Scand., p. 10, 1846; Herrmannsen, Indicis Gen. Malac., Supplement, p. 42, 1852, type, *Bulla cylindracea* Pennant; not *Cylichnus* Burmeister, Handb. der Entomologie, Vol. 4, p. 171, 1844, Coleoptera, *fide* Pilsbry, in Tryon, Man. Conch., Ser. 1, Vol. 15, p. 287, 1893.

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[1] Geol. Surv. Calif., Palaeo., Vol. 1, pp. 143, 144, 229 (in part), pl. 2, fig. 107, 1864. Stewart has discussed this species in his paper on Gabb's fossil type gastropods: Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 437, pl. 27, fig. 5, 1927.

[2] Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 56, pl. 5, fig. 68, 1916, *Molopophorus lincolnensis* zone.

Bullinella R. B. Newton, Syst. List Edwards Coll. Brit. Olig. Eoc. Moll., p. 265, 1891, new name for *Cylichna* Lovén, not *Cylichnus* Burmeister.

Type (by subsequent designation, Herrmannsen, 1852), *Bulla cylindracea* Pennant, Recent, European seas.

Geologic range: Cretaceous (?) to Recent.

This genus includes small, cylindrical shells with the posterior end truncated and with the spire involute, leaving a small apical concavity. The aperture is long and narrow, dilated below, and the columella bears one oblique fold on its base. Sculpture is absent or confined to fine spiral striæ and growth lines.

Cylichnella Gabb[1] differs from *Cylichna* in possessing two columellar folds. The California Quaternary species, according to the shell characters, should belong in *Cylichna* and cannot be placed in *Cylichnella*. Anatomical characters, now largely unknown, may require a revision of the group.

The name *Bullina* Risso is preoccupied. *Cylindrella* Swainson was used in two different senses by its author in the same work, and the same name was used the same year by Pfeiffer. *Bullinella* Newton was proposed as a substitute for *Cylichna* Lovén, as we now think unnecessarily, because it was formerly thought that *Cylichnus* Burmeister, 1844, preoccupied the name.

The Pacific coast Recent species of *Cylichna* (*Cylichnella* of authors) appear to intergrade, according to A. M. Strong,[2] but Pacific coast collections do not yet contain large enough series to warrant definite conclusions. The five supposed species listed by Dall[3] appear to be supplied with several synonyms. Misidentifications have no doubt found their way into the literature, and the situation is somewhat confused.

But two species of *Cylichna* have been reported from the Pliocene or Pleistocene of the Pacific coast.

Cylichna alba (Brown)

Volvaria alba Brown, Illust. Conch. Gt. Brit. Irel., p. 3, pl. 19, figs. 43, 44, 1827.

Bulla triticea Couthouy, Boston Journ. Nat. Hist., Vol. 2, p. 88, pl. 1, fig. 8 (not pl. 2, as stated), 1838.

Cylichna alba (Brown) Lovén, Ofversight Vet. Akad. Forh., p. 142, 1846; Jeffreys, Brit. Conch., Vol. 4, p. 417, pl. 8, fig. 1*a*, 1867; Vol. 5, p. 223, pl. 93, fig. 6, 1869; Ann. Mag. Nat. Hist., Ser. 4, Vol. 10, p. 241, 1872; Sars, Moll. Arct. Norv., p. 283, pl. 17, figs. 15, 16, 1878; Pilsbry, in Tryon, Man. Conch., Ser. 1, Vol. 15, pp. 290, 291, 1893; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 192, pl. 10, fig. 18, 1903; T. S. Oldroyd, Nautilus, Vol. 28, p. 81, 1914.

"*Cylichna cylindracea* Linnæus," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 647, 1864, not of Linnæus; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 238, 1888.

Cylichna elongata Locard, Coq. Mar. Côtes France, p. 25, 1892, *fide* Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 15, p. 291, 1893.

Cylichnella (*Bulinella*) *alba* (Brown), Dall, Bull. 112, U. S. Nat. Mus., p. 63, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 73, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, p. 39, pl. 2, fig. 5, 1927.

Type locality: Greenock, Britain.

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[1] Proc. Acad. Nat. Sci. Phila. for 1872, pp. 273, 274, pl. 10, fig. 2, Feb. 11, 1873; type *Bulla bidentata* d'Orbigny, not of Gabb, which = *Cylichnella ovumlacerti* (Guppy), *fide* Pilsbry, Proc. Acad. Nat. Sci. Phila. for 1921, pt. 2, p. 311, text figs. 6, 7, 1922.

[2] Verbal communication.

[3] U. S. Nat. Mus., Bull. 112, p. 63, Feb. 24, 1921.

Pliocene: San Diego well, Balboa Park, San Diego (Cooper, 1888).

Pleistocene: Lower San Pedro series at Deadman Island, Los Angeles County; upper San Pedro series at San Pedro, rare (Arnold, 1903); lower San Pedro at Nob Hill cut, Los Angeles County, "two specimens" (T. S. Oldroyd, 1925); Pleistocene at Signal Hill, two miles from Long Beach, California (T. S. Oldroyd, 1914); Pleistocene of Spanish Bight, San Diego (Arnold, 1903; Mrs. K. Stephens, MS.); Pleistocene at Barlow's Ranch, near Ventura (Arnold, 1903); Pleistocene of the Palisades at Santa Monica (collection of F. C. Clark).

Recent: Circumboreal; Arctic Ocean to San Diego, California (Dall).

This species is less elongate and less cylindrical than *C. attonsa* Carpenter. It does not have the anterior portion of the lip produced as much as does *C. diegensis* (Dall). The latter was described as having the apex minutely perforate.

Carpenter and others have apparently confused some of the Pacific coast species of *Cylichna*, and some of the old identifications are doubtful. *C. alba* is very widespread and occurs in the Pliocene deposits of England.

Cylichna petrosa (Conrad)

Bullina petrosa Conrad, Amer. Journ. Sci., Ser. 2, Vol. 5, p. 433, fig. 11, 1848; Dall, reprint of original in U. S. Geol. Surv., Prof. Paper 59, p. 151, fig. 11, 1909, not *Bulla petrosa* Conrad, 1849 = *Haminoea petrosa* (Conrad).

Cylichna petrosa Conrad, Amer. Journ. Conch., Vol. 1, p. 151, 1865.

Cylichnella petrosa Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 23, April, 1909.

Miocene: "Of Columbia River, Oregon, near Astoria" (Conrad, 1848; Dall, 1909).

Conrad's original description is as follows: "Narrow-cylindrical; margin of labrum straight, extremity elevated above the apex; spire slightly raised above the shoulder, which is oblique and angulated."

Dall (1909) stated that the species had some resemblance to *cylindracea* but was more slender.

Cylichna diegensis (Dall)

Cylichnella (*Bullinella*) *diegensis* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 300, 1919; Bull. 112, U. S. Nat. Mus., p. 63, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 40, 1927.

Cylichnella diegensis Dall, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Type specimen: In the U. S. National Museum, No. 209071.

Type locality: Off Point Loma, San Diego County, California, in 98 to 191 fathoms, muddy bottom.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (E. K. Jordan).

Recent: "San Diego, California, to Cape San Lucas. Vancouver Island ?" (Dall, 1921).

This species is distinguished by the anterior projection of the aperture and the much thickened pillar lip. It may be *C. propinqua* E. A. Smith[1] but not the "*Bulla*" *propinqua* of M. Sars. It may also be, in part, the "*C. cylindracea* Linnæus" of Carpenter, 1864, not of Linnæus.

Cylichna attonsa Carpenter

Cylichna (*? cylindracea*, var.) *attonsa* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 537, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 58, April, 1865; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 303, 1893.

Cylichna (? var. *attonsa*) Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 603, 1864.

Cylichna ? cylindracea var. *attonsa* Carpenter, *op. cit.*, p. 647, 1864.

Cylichna attonsa Carpenter, *op. cit.*, p. 683, 1864.

Cylichnella (*Bullinella*) *attonsa* (Carpenter), Dall, Bull. 112, U. S. Nat. Mus., p. 63, 1921, "San Diego" ?; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 40, pl. 2, fig. 8, 1927.

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[1] Ann. Mag. Nat. Hist., Ser. 4, Vol. 9, p. 351, 1872.

Type specimen: In the Academy of Natural Sciences of Philadelphia (*fide* Oldroyd).

Type locality: Puget Sound.

Pleistocene: At mouth of Elk River, Oregon (Arnold and Hannibal collection, Stanford Univ.).
Recent: Puget Sound (to San Diego, California, Oldroyd, 1927).

This species is so imperfectly known that records of its occurrence must be carefully verified. Dall gives the range merely as "San Diego, California," which is not consistent with Carpenter's original description and lists. It is quite possible that Carpenter redescribed *Cylichna alba*, as he appears not to have considered that species in the references given above.[1]

In the Arnold and Hannibal collection at Stanford University there are two specimens labeled "*Cylichna attonsa* Cpr., Mouth of Elk River, Ore." The largest measures 12 mm. in axial length, by 4 mm. in diameter. They do not fit the measurements of *C. nucleola* Reeve[2] nor *C. occulta* Mighels,[3] and they may be *attonsa*, although the measurements of that species suggest a different shape.

Family BULLIDAE

Shell wholly external, globose, oval or oblong-cylindric, with umbilicated vertex (rarely covered) and sunken spire, mottled color pattern and rather smooth surface; aperture as long as the shell, rising above the vertex, narrow above, dilated below; columella simply concave, with reflexed crescentic callus and no fold. (Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 326, 1893.)

Pilsbry separated the Bullas from the family *Akeridæ* on the basis of considerable differences in anatomy. The *Scaphandridæ* are somewhat similar in radular characters, although that family is carnivorous, while the *Bullidæ* represent an exclusively herbivorous group.

Genus BULLUS Montfort, 1810

Bulla Linnæus, Syst. Nat., Ed. 10, p. 725, in part only, not of p. 427, 1758; Schumacher, Essai Nouv. Syst. Hab. Vers Test., p. 257, 1817; etc.

Bullus Montfort, Conchyl. Syst., Vol. 2, pp. 330-332, 1810.

Bullites Schlotheim, Tasch. Min., p. 92, 1813, *fide* Sherborn, Index Anim., Sect. 2, p. 933; not of Gmelin, Syst. Nat., Ed. 13, p. 414, 1793.

Bullea Blainville, Man. Malac., p. 477, Oct., 1825; type, *Bulla ampulla* Linnæus, designated by Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 145, 1846.

"*Bullaria* Rafinesque," 1815, Dall, *et auct.*

Type (by monotypy) "*Bulla ampulla* de Lamarck" = *Bulla ampulla* Linnæus.

Shell attaining a large size, rather solid, ovate or globose; spire involute, with a small but deep apical perforation; aperture long, anterior end dilated, posterior end narrow and extending above the vertex of the shell; inner lip a callus wash on the body whorl, columella simple, gently curving anteriorly into the outer lip, callus deposit heavy and sharply delimited, in typical species covering the umbilical region; sculpture absent or consisting of fine spiral grooves and growth lines.

Geologic range: Jurassic to Recent (*fide* Cossmann, Ess. Paléo. Comp., Vol. I, p. 91, 1895.

Distribution: Warm and temperate seas.

The synonymy given above should be compared with that cited under *Scaphander*. The generic name *Bulla* Linnæus was rejected for use in the Mollusca over a hundred years ago by Rafinesque. Since that time several generic names have been proposed for the group. *Bullus* Montfort is four years earlier than *Bullaria* Rafinesque; and as Montfort clearly designated as type *B. ampulla*, the group should take the name *Bullus*. If the International Commission on Zoological Nomenclature should resurrect the use of *Bulla* for Mollusca, this name, which ought to have been forgotten long ago after its rejection as a homonym, will have to be used for the group now so well known under the name of *Scaphander* Montfort. This cannot be avoided unless it is assumed that Montfort designated the type of *Bulla* Linnæus when he cited the type of his own genus *Bullus*. Such an assumption is unwarranted and if done in other cases will lead to more confusion.

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[1] Mr. A. M. Strong has kindly called our attention to this confusion.

[2] Last of the Arctic Voyages, Vol. 2, p. 393, pl. 32, fig. 2, 1855.

[3] Proc. Boston Soc. Nat. Hist., Vol. 1, p. 50, 1841; Boston Journal of Natural History, Vol. 4, pl. 14, fig. 11, 1844.

If *Bullus* Montfort is rejected, *Bullites* Schlotheim, 1813 (also of Kruger, 1823, Geschichte der Urwelt, *fide* Iredale, Proc. Malac. Soc. London, Vol. 14, 1921) cannot be used, as that name is a homonym of *Bullites* Gmelin, 1793.

Bullus punctulatus (A. Adams)

Bulla punctulata A. Adams, in Sowerby's Thes. Conch., Vol. 2, pp. 577-578 (as *punctata* by mistake, not *punctata* Schroeter, corrected on p. 604), pl. 123, fig. 77, 1850; Carpenter, Proc. Zool. Soc. London for 1863, p. 359, 1864; Pilsbry, in Tryon's Man. Conch., Vol. 15, p. 341, pl. 37, fig. 39, pl. 36, figs. 29, 30, 1893; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 193, 1903.

? Bulla adamsi Menke, Zeitschr. f. Malak., p. 162, 1850, excl. synonymy, *fide* Pilsbry.

"*Bulla adamsii* Menke," Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 162, 1857; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 230, 1888.

Bullaria punctulata A. Adams, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 199, 1909.

Shell oval, solid; surface smooth, showing under a strong lens exceedingly close and fine, wavy striations; exterior indistinctly clouded with flesh color on a lighter ground, and usually obscurely blotched with dark in two ill-defined girdles, the whole surface showing few or many dark dots shaded on the left side, white-edged on the right; interior of aperture marked with whitish lines, scarcely showing the external markings; vertex umbilicated, the interior of the umbilicus sculptured with deep spiral grooves, about a dozen in number; columella bearing a heavy lunate callus, which is often brown-edged; parietal callus thick and heavy. Altitude, 25 mm.; diameter, 16 mm. (From Pilsbry, much altered.)

Pliocene: San Fernando, Los Angeles County (Cooper).
Pleistocene: Upper San Pedro series of Deadman Island, Los Cerritos, Crawfish George's, and San Pedro (Arnold).
Recent: Gulf of California to Lobos Islands, Peru (Dall, 1910).

It is probable that this form and *B. aspersus* A. Adams, both described at the same time, are synonyms of *B. panamensis* Philippi,[1] described two years earlier; but the material is not at hand to settle this question.

Bullus aspersus (A. Adams)

Bulla aspersa A. Adams, in Sowerby's Thes. Conch., Vol. 2, p. 578, pl. 123, fig. 78, 1850; Sowerby, in Reeve's Conch. Icon., Vol. 16, *Bulla*, sp. 18, pl. 6, figs. 18*a*, 18*b*, March, 1868; Pilsbry, in Tryon's Man. Conch., Vol. 15, p. 341, pl. 36, figs. 25, 26, 27, 28, 1893.

Bullaria aspersa A. Adams, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 199, 1909; Dall, Nautilus, Vol. 23, p. 23, 1918.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall).
Recent: Panama to Paita, Peru (Dall, 1909); Galapagos ?

Dall reported this species as collected by C. R. Orcutt from the Pleistocene of Magdalena Bay. It is possible that *aspersus* is the same species as *punctulatus;* or, if distinct, the Magdalena Bay fossil may be *punctulatus*. These species are not well known and descriptions are not reliable unless based on the type specimens.

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[1] Zeitschr. f. Malac., p. 141, unfigured, 1848.

Bullus quoyanus (Dall)

Bulla quoyii Gray, MS. Brit. Mus., A. Adams, in Sowerby's Thes. Conch., Vol. 2, pp. 576, 577, pl. 123, fig. 71, 1850; not *Bulla quoyii* Gray, Dieffenbach's New Zealand, Vol. 2, p. 243, 1843; Pilsbry, in Tryon's Man. Conch., Vol. 15, p. 348, pl. 39, fig. 71, 1893.

"*Bulla quoyi* Gray," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 193, pl. 8, fig. 8, 1903.

Bullaria quoyana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 300, 1919, new name for *Bulla quoyi* A. Adams, 1850, not Gray, 1843; Bull. 112, U. S. Nat. Mus., p. 63, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 41, 1927.

Type specimen: In the British Museum.

Type locality: Galapagos Islands.

Pleistocene: Upper San Pedro series of San Pedro, rare (Arnold).
Recent: Catalina Island, California, to Acapulco, Mexico (Dall).

Only a critical study of the Pacific coast "Bullas," based as far as possible on the type specimens, or lacking them, on topotypes, can settle the confusion that obscures these species. The records of occurrences given in this report are based merely upon the literature.

Bullus gouldianus (Pilsbry)

Bulla nebulosa Gould, A. Adams, in Sowerby's Thes. Conch., Vol. 2, p. 578, pl. 123, figs. 79, 80, 1850; Menke, Zeitschr. f. Malak., p. 162, 1850; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 198, 233, 234, 237, 284, 289, 313, 352, 353, 1857; Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., pp. 172, 540, 1857; Proc. Zool. Soc. London for 1856, p. 220, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 536, 540, 593, 599, 621, 646, 665, 667, 1864; reprinted in Smithsonian Misc. Coll., No. 252, 1872; Sowerby, in Reeve's Conch. Icon., Vol. 16, *Bulla*, sp. 6, figs. 6*a*, 6*b*, 6*c*, Jan., 1868; Keep, West Coast Shells, p. 126, fig. 117, 1888, 1892; not *Bulla nebulosa* Schroeter, Archiv f. Zool. u. Zoot. (Wiedemann), Vol. 4, p. 20, 1804.

Bulla gouldiana Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 340, pl. 36, figs. 22, 23, 24, 1893; Keep, West American Shells, p. 111, fig. 97, 1904.

Bullaria gouldiana Pilsbry, Dall, Bull. 112, U. S. Nat. Mus., p. 63, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, no. 7, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 41, 1927.

Type specimen: In the British Museum.

Type locality: Gulf of California; Guaymas ?.

Pleistocene: Upper San Pedro at Signal Hill, Los Angeles County; upper San Pedro fauna at San Pedro (T. S. Oldroyd Collection); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926).
Recent: Santa Barbara, California, to Mazatlan, Mexico (Dall, 1921).

This large species is much thinner than *B. ampullus.* It is larger than any other American form and has a characteristic pattern of coloration and microscopic sculpture. (Pilsbry, 1893.)

The surface of the shell of this species is microscopically granulose.

Bullus striatus (Bruguière)

Bulla striata Bruguière, Encycl. Méth., Hist. Nat. Vers, Vol. 1, p. 372, 1792; Philippi, Enum. Moll. Siciliæ, Vol. 1, p. 121, 1836; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, pp. 332, 333, pl. 37, figs. 42-46, 1893.

Bulla columnæ Della Chiage, Test. Utr. Sicil., Vol. 3, pt. 2, p. 24, pl. 46, figs. 17, 18, 1827.

Bulla paupercula Sowerby, Quart. Journ. Geol. Soc. London, Vol. 6, p. 52, unfigured, 1850; Guppy, Vol. 32, p. 518, 1876.

Bulla omphalodes Menke, Zeitschr. f. Malak., p. 137, 1853; Malak. Blät., Vol. 1, p. 44, 1854, *fide* Pilsbry, 1893.

Bulla dactylis Menke, Zeitschr. f. Malak., p. 137, 1853, *fide* Pilsbry, 1893.

Bulla striata var. *attenuata* Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 2, p. 219, pl. 13, fig. 10*a*, 1890.

Not "*Bulla striata* Bruguière," Guppy, Geol. Mag., Decade 2, Vol. 1, p. 437, 1874; nor of Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 6, p. 1583, 1903, *fide* Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 130, 1928.

Bullaria paupercula Sowerby, Maury, Bull. Amer. Paleo., Vol. 5, p. 182 (No. 29, pp. 18, 19), pl. 3, fig. 8, 1917.

Bullaria striata Bruguière, Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, pp. 442, 443, pl. 20, fig. 9, 1926.

Pliocene: From the first narrow box canyon east of Alverson Canyon, Coyote Mt., Imperial County, Calif. (G. D. Hanna, 1926); Pliocene of Florida (Dall, etc.).

Recent: Mediterranean; Atlantic coasts of Portugal and Morocco; also Florida.

This species has microscopic spiral striations, with a few more prominent, more widely spaced grooves near each end of the shell. The umbilical perforation is wide, open, deep, and has closely-spaced spiral grooves within. Pilsbry has discussed the variations and distribution of this species in the reference given above.

The *"Bulla" petrosa* Conrad (Miocene), of the U. S. Exploring Expedition Report, is a *Haminoea*, according to Dall.

Family AKERIDAE

Shell oval or cylindrical, *thin*, and fragile, of a light yellowish brown or green tint, the spire low or concealed. (Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, p. 350, 1893.)

Genus HAMINOEA Turton and Kingston, ? 1830

Haminoea Turton and Kingston, The Teigmouth, Dawlish, and Torquay Guide, pt. 2, Nat. Hist. of the District, p. ?, 1830, *fide* Iredale, Proc. Malac. Soc. London, Vol. 11, p. 172, 1914; issued as separate "Enumer. Marine Shells Found on the Dartmouth Coast," 1829 ?, *fide* Cat. Nat. Hist. Books in Brit. Mus., Vol. 5, p. 2155, 1915.

Haminea Leach MS., Gray, Proc. Zool. Soc. London for 1847, p. 161, 1847.

Type (by subsequent designation for *Haminea*, Gray, 1847), *Bulla hydatis* Linnæus, Recent, Atlantic coasts of Spain and France, and Mediterranean Sea.

Geologic range: Miocene to Recent (Cossmann, Ess. Paléo. Comp., Vol. 1, p. 92, 1895).

Distribution: World wide in tropic and temperate seas.

This genus is characterized by its thin shell, which may be partly corneous and flexible, and is generally unicolored, with a thin epidermis, and has a simple and minutely perforated apex. The umbilicus is closed. The shape is ovate or ovate-cylindric and its appearance is much like that of *Bullus*, although the two genera are said to be very distinct anatomically.

Iredale has shown that the generic name dates from at least as early as 1830 and that the original spelling was with an "*o*."

Haminoea cymbiformis Carpenter

? *Bulla virescens* Sowerby, Genera of Shells, Pt. 39, fig. 2, 1833 (?), (for date see R. B. Newton, Cat. Edwards Coll. Brit. Olig. Eoc. Moll. Brit. Mus., p. 322, 1891, and Sherborn, Ann. Mag. Nat. Hist. Ser. 6, Vol. 13, p. 371, 1894.)

? *Bulla* (*Haminea*) *virescens* Sowerby, A. Adams, in Sowerby's Thes. Conch., Vol. 2, p. 579, pl. 124, fig. 83, 1850.

"*Bulla* (*Haminea*) *virescens* Sowerby," Gould, U. S. Pacific R. R. Reports, Vol. 5, p. 330, 1856.

Haminea cymbiformis Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 174, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 545, 646, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 31, 132 (bottom pagination), 1872.

"*Haminea virescens* Sowerby," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 545, 646, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 31, 132 (bottom pagination), 1872; Keep, West Coast Shells, p. 126, 1888, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 1, p. 18, 1890; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 195, 1892; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 15, pp. 360, 361, 1893; Bradshaw, Nautilus, Vol. 8, no. 9, p. 101, pl. 2, fig. 15, 1895; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 194, pl. 8, fig. 18, 1903; I. S. Oldroyd, Nautilus, Vol. 31, p. 98, 1918.

Haminoea virescens Sowerby, Dall, Bull. 112, U. S. Nat. Mus., p. 63, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 42, 1927.

Haminoea dalli Bartsch, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925, nude name.

Haminoea strongi Baker and Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, pp. 130-131, pl. 4, fig. 2, 1927.

Type specimens: Of *virescens*, in the British Museum (?); of *cymbiformis*, in the British Museum, Mazatlan Collection; of *strongi*, at the California Academy of Sciences.

Type localities: Of *virescens*, Pitcairn Island, southwestern Pacific (?); of *cymbiformis*, Mazatlan, Mexico; of *strongi*, Gulf of California, Mexico.

? Pliocene: Caloosahatchie beds, Florida (Dall, 1900).

Pleistocene: Rare in the upper San Pedro series at San Pedro, Los Angeles County (Arnold, 1903); "plentiful" in the lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd, 1925, as "*H. dalli* Bartsch, new species").

Recent: Santa Barbara, California, to Puerto Libertad, Mexico (Dall, 1921); Puget Sound (Oldroyd, 1918); ? western Pacific; ? Atlantic.

This species is characterized by the constriction of the apical portion of the shell and by the dilated anterior part of the aperture. The shell is thin and typically of a pale greenish color. A. M. Strong states that in southern California the form found in the lagoons and bays has a dark brown periostricum not found on specimens living in the open ocean. The specimens of "*Haminoea dalli* Bartsch, new species," collected by T. S. Oldroyd from Nob Hill, San Pedro Pleistocene, are apparently of this species; but the green color is gone, and the specimens do not attain the size reached by some large living individuals.

Dall stated that the Florida Pliocene specimens of "*virescens*" were identical with Recent Pacific coast representatives.

This species has been known for a long time under the name *virescens* (Sowerby), in spite of the fact that the type locality of Sowerby's species is given as Pitcairn Island, in the southwestern Pacific. Indeed, when the illustrations and descriptions of the eastern Pacific and western Pacific forms are compared, it is not surprising that the older writers, who had no preconceived opinions about the limited distribution of species, should consider the two the same. The California and the south Pacific form are surprisingly similar in shape, size, and even sometimes in coloration, and objectively considered, there is practically nothing to distinguish them. It is possible that the two occurrences represent isolated remnants of a species that once had a continuous distribution around the borders of the north Pacific, as other species such as *Psephœa prevostiana* once had; and being a primitive type of shell, with few characters, it may have survived essentially unchanged on the opposite sides of the Pacific, driven southward in the later Cenozoic by the oncoming of colder temperatures. If the fossil record should give evidence to bear out this possible history, and if on careful comparison the two forms could not be separated objectively, then the name *virescens* should again be applied to the California and Lower California shells. In the meantime, however, since the fossil record is not well known and the hypothesis of parallel development is at least equally plausible and is much more in favor among conchologists, it seems better to use a local name.

The oldest available local name that has been applied to this species is *cymbiformis* Carpenter. It is unfortunate that Carpenter's type is a very young, imperfect specimen, not very fully described and never figured. Nevertheless, Carpenter himself identified it with *virescens* and abandoned his name in favor of Sowerby's older one, being followed in this respect by Dall, Arnold, and others. The evidence for the identification of Carpenter's name is none too satisfactory, but as much of it as there is all points to the conclusion that Carpenter's species is the same as the California and west Mexican species generally known as *virescens* and more recently described as *strongi* by Baker and Hanna. Carpenter, being presumably the one who has known more about the shell he described than anyone else, and being in a position to know what was generally called *virescens*, came to this conclusion; and at the same time he knew and recognized in his report the only other distinct species of *Haminoea* in the region, *H. vesicula*. As no evidence has been presented to show that Carpenter did not have the species here assigned to *cymbiformis*, the burden of the proof falls on those who wish to doubt his conclusions. His shell agrees, according to the description, with the figure and description of *strongi* in its thin shell, cymbiform shape, and very fine spiral striations. Thus the present writers conclude that the name *strongi* must fall as a synonym of the earlier *cymbiformis*.

In a recent, very hurried visit to the British Museum, Mr. Gale found the type specimen of *cymbiformis*, along with the rest of Carpenter's Mazatlan material, clearly marked with the original inscription. However, without comparative California and Lower California material, and in the very short time available, it was not possible to settle the morphological and nomenclatorial problems discussed above.

Haminoea vesicula (Gould)

Bulla (Haminea) vesicula Gould, U. S. Pacific R. R. Repts., Vol. 5, Appendix, p. 334, pl. 11, fig. 29, 1856 (Prelim. Rept., 1855, U. S. House of Representatives Doc. 129, not available).
Haminea vesicula Keep, West Coast Shells, p. 126, fig. 116, 1888, 1892; West American Shells, p. 112, fig. 98, 1904.
Haminoea vesicula Gould, Dall, Bull. 112, U. S. Nat. Mus., p. 63, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 9, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 42, 1927.

Type specimen: In the U. S. National Museum.

Type locality: San Diego, California; Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, Los Angeles County, "not rare" (T. S. Oldroyd).
Recent: Southeastern Alaska to the Gulf of California, Mexico.

This species is not constricted near the apex, as are *H. virescens* (Sowerby) and *cymbiformis* Carpenter. Mr. George Willett of the Los Angeles Museum has a specimen apparently of *vesicula* obtained by him at Ketchikan, southeastern Alaska, which extends the previously known range northward from Vancouver Island.

Haminoea petrosa (Conrad)

Bulla petrosa Conrad, U. S. Expl. Exped. (Wilkes), Vol. 10 (Geol.), p. 727, pl. 19, fig. 8, 1849.
Cylichna oregona Conrad, Amer. Journ. Conch., Vol. 1, p. 151, 1865.
Haminea petrosa Conrad, Arnold, Proc. U. S. Nat. Mus., Vol. 34, pl. 33, fig. 17, 1908; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 23, 1909.

Type specimen: In the U. S. National Museum, No. 3607.

Type locality: Miocene of Astoria, Oregon.

Oligocene: On San Lorenzo River, three miles above the town of Boulder Creek, Santa Cruz County, California (Arnold, 1908).
Miocene: Astoria, Oregon.

Dall, who had seen Conrad's type, stated that the species was undoubtedly a *Haminoea*. The original figure in the geology atlas of the Wilkes Exploring Expedition report conveys little idea of the characters of the shell except for the elongate, subcylindric shape and the truncate apex. It appears very little like typical *Haminoea*, and recalls some species of *Cylichna*. Arnold (1908) figured a specimen from the San Lorenzo formation (Oligocene) of Santa Cruz County, but the figure is not similar to the shape suggested by Conrad's drawing. The two may not be conspecific.

ORDER PULMONATA

Superfamily Akteophila

Family ELLOBIIDAE

Genus MELAMPUS Montfort, 1810

Melampus Montfort, Conchyl. Syst., Vol. 2, pp. 318-320, 1810; Herrmannsen, Indicis. Gen. Malac., Vol. 2, p. 27, July 17, 1847; Gray, Proc. Zool. Soc. London for 1847, p. 179, Nov., 1847; Dall, Proc. U. S. Nat. Mus., Vol. 8, p. 280, 1886.

Conovulus Lamarck, Extr. Cours Zool., 1812; Bowdich, Elem. Conch., pp. 28, 63, 1822, *fide* Dall.

Rhodostoma Swainson, Treat Malac., p. 344, 1840.

Type (by original designation), *Bulimus coniformis* Bruguière = *Bulla coffea* Linnæus, Syst. Nat., Ed. 10, p. 729, 1758; Barbados, Recent; figured by Dall, Proc. U. S. Nat. Mus., Vol. 8, pl. 18, fig. 3, 1886.

Shell ovate-conic; spire low; aperture somewhat elongate, gently rounded below; inner lip polished, but not incrusted, bearing plications; outer lip generally thin, simple, sometimes bearing within lirations or a row of denticulations; umbilicus closed or a mere chink; no developed anterior canal nor posterior notch; sculpture absent or reduced to growth lines. Size generally small, average length for genus about 12 or 15 mm.

Geologic range: Tertiary to Recent.

Distribution: Warm and temperate regions.

The species of this genus inhabit bays, lagoons, tidal marshes, deltas, etc. They live either in quiet marine or brackish waters and can often be found crawling on the mud or on grasses. They are amphibious.

The subgenus *Leuconia* Gray,[1] according to Dall, can be used for the forms with a produced spire and a somewhat thickened outer lip.

Melampus olivaceous Carpenter

Plate 24, Figure 16

Melampus olivaceous Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 178, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, p. 647, 1864; Dall, Proc. U. S. Nat. Mus., Vol. 8, p. 283, pl. 18, fig. 16, 1886; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 250, 1888; Keep, West Coast Shells, p. 124, fig. 113, 1888; 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 196, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 197, 1903; T. S. Oldroyd, Nautilus, Vol. 28, no. 7, p. 82, 1914; Dall, Bull. 112, U. S. Nat. Mus., p. 66, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, no. 7, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, pp. 54, 55, pl. 1, fig. 16, 1927.

Type specimen: In the Liverpool Collection.

Type locality: Mazatlan, Mexico; Recent.

Pliocene: San Diego well (Dall).

Pleistocene: Signal Hill, near Long Beach, Los Angeles County (T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey Bay (Salinas River), California, to Mazatlan, Mexico (Dall, 1921).

There is only one living species of *Melampus* on the coast of California. It is a small, olive-brown, ovate-conic shell with indistinct revolving color bands intersected by growth lines and occasional axial color bands. Large specimens measure 10 mm. in length by 7 mm. in width.

This species is not uncommon in the bays and lagoons of southern California. It frequently occurs on damp eel-grass just above tide level.

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[1] Turton, Man., Ed. 2, p. 227, 1840; Proc. Zool. Soc. London for 1847, p. 179, 1847; Turton, Man., Ed. 3, p. 195, 1857. Dall (1886) cited "*Voluta*" *bidentata* Montagu as type of *Leuconia*, but Gray (1847) had already selected "*Voluta alba*" as type forty years previously.

Superfamily PETROPHILA

Family GADINIIDAE

Genus GADINIA Gray, 1824

Gadinia Gray, Tilloch's Philos. Mag. (London), Vol. 63, p. 274, 1824; Gray, Proc. Zool. Soc. London, p. 181, 1847; Dall, Amer. Journ. Conch., Vol. 6, pp. 8, 9, 1870; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, fasc. 12, p. 483, 1886; Cossmann, Ess. Paléo. Comp., Vol. 1, p. 145, 1895.

Clypeus Scacchi, Osservazioni Zoologiche, p. ?, 1833, *fide* Dall.

Mouretia Sowerby, Proc. Zool. Soc. London for 1835, p. 6, 1835; Gray, Proc. Zool. Soc. London for 1847, p. 181, 1847.

"*Muretia*" Sowerby, d'Orbigny, Voy. Amer. Mérid., Vol. 5, pp. 470, 682, 1846, in part, *fide* Dall, 1870.

Rowellia Cooper, Proc. Calif. Acad. Nat. Sci., p. 188, 1865 (= *Gadinia juv.*, *fide* Dall, 1870).

Type (*fide* Gray, 1847), *Gadinia afra* Gmelin (*Lepas Gadin* Adanson, 1857), west coast of Africa, Recent.

Shell low, conical, or dome-shaped; apex blunt, central, or subcentral; sculpture radial or irregular; interior simple, without septum, an arcuate muscle scar above the margin. Animal an air-breather, with a lung and without gills.

Geologic range: Miocene to Recent (? Paleocene), *fide* Cossmann, 1895.

Distribution: Warm and temperate seas; Mediterranean, Africa, Australia, North and South America, etc.

The genus occurs at least as early as the Miocene, both in California and in Europe. The Paleocene record of Cossmann is based upon a species which is doubtfully a *Gadinia*.

It is likely that imperfectly preserved fossil specimens of *Gadinia* have been misidentified as *Acmæa*. Both of these genera have a conical shell and a horseshoe-shaped internal muscle scar; but the base of *Gadinia* is round, whereas that of *Acmæa* has a somewhat elongate shape. The anatomy is vastly different. *Calyptræa* differs in its spiral shell and internal spiral septum; but some poorly preserved fossil Calyptræas do not show the interior of the shell nor the spiral sutures and may simulate *Gadinia*. *Hipponix* is generally flatter, more irregular, and has coarser growth lamellæ. All these genera, of course, are very different from each other, their similarities being quite superficial; but poor preservation often makes differentiation difficult.

Gadinia is indicated as a homonym in Agassiz's Nomenclator, the name having had a prior use in Ichthyology by Rafinesque, 1815. Rafinesque's paper in which this name is used is not available to the present writers, but the use of *Gadinia* for fishes was probably not in a generic sense. It is not mentioned in Jordan's Genera of Fishes.

Gadinia reticulata (Sowerby)

Mouretia reticulata Sowerby, Proc. Zool. Soc. London, p. 6, 1835.

Siphonaria reticulata Sowerby, d'Orbigny, Voy. Amer. Mérid., Vol. 5, p. 682, 1846.

Gadinia reticulata H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 463, 1854; Dall, Amer. Journ. Conch., Vol. 6, pt. 1, pp. 11, 12, pl. 2, figs. 1-9, pl. 4, figs. 1-3, 1870; ? Garrett, Journ. Conch., Vol. 1, p. 335, 1878; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 422, 1915; Dall, Bull. 112, U. S. Nat. Mus., p. 66, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, pp. 55, 56, pl. 2, figs. 16*a*, 16*b*, 1927.

Rowellia sp. Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 651, 1864.

Rowellia radiata Cooper, Proc. Calif. Acad. Nat. Sci., p. 188 (*juv.*), 1865.

"*Gadinia stellata* Sowerby" of some early California collectors, not of Sowerby, a variable Gulf of California shell, probably including *pentegoniostoma* Sowerby, also described as a *Mouretia*.

Type specimen: Presumably in the British Museum.

Type locality: Not Valparaiso, Chile, *fide* Dall, 1870.

Miocene: Upper San Pablo, upper Miocene, of central California (Clark, 1915).
Recent: Trinidad and the Farallone Islands, California, to Cape San Lucas, Lower California (Dall, 1921).

The shell of this species has the shape of a low cone or rounded dome. The apex is nearly central, but is inclined to be a little posterior. The tip of the spire, which is not twisted, may be eroded or submerged in the shell. The sculpture, when not eroded or obliterated by borings, consists of rounded radial ribs and annular growth lines and coarser rugæ. The interior of the shell has a muscle scar situated not quite half of the distance from the margin to the apex, the scar being not a complete circle. Full-grown individuals measure as much as 25 mm. in diameter and 12 mm. in height.

The shell of this species is readily distinguished from that of the limpets by its rounded basal margin and peculiar radial sculpture. *Lepeta* is generally smoother on the exterior and is elongate.

The specimen upon which the Miocene record is based has not been examined.

Family SIPHONARIIDAE

Shell patelliform, unsymmetrical; adductor impression on the shell interrupted by a lateral sinus corresponding to the pulmonary orifice and situated at the anterior side. (Cossmann, Ess. Paléo. Comp., Vol. 1, p. 135, 1895.)

Genus WILLIAMIA Monterosato, 1884

Williamia Monterosato, Nomen. Gen. e. Spec. di Alcune Conch. Medit., p. 150, 1884; Woodring, Carnegie Inst., Publ. No. 385, p. 111, 1928.

Type (by monotypy), *Ancylus ? gussonii* da Costa; Recent, Mediterranean (*fide* Woodring, *op. cit.*, p. 111).

Shell small, thin, patelliform. Apex near posterior end, twisted to left. Aperture rounded, ovate. Muscle impression horseshoe-shaped, the anterior ends joined by a shallow groove, interrupted on the right side by a wide, obscure groove. Surface smooth or bearing obscure radial waves. (Woodring, 1928.)

This genus differs from *Siphonaria* Sowerby[1] in that its apex is spirally twisted to the left. This character is not always evident, as many specimens of *W. peltoides* have a blunt, recumbent apex that is either partly eroded or submerged in the cone-shaped exterior surface of the shell. It must not be confused with the eccentric position of the apex of such species as *Siphonaria thersites* Carpenter, which has a lopsided appearance because the apex is situated to the left of the geometric center of the shell. Both genera are sedentary groups of mollusks.

Dall has discussed the anatomy of the *Siphonariidæ* in Volume 6 of the American Journal of Conchology.

Williamia peltoides (Carpenter)

Nacella sp. ind., Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 202, 1857.
Nacella peltoides Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 474, June, 1864; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 545, 618, reprinted in Smithsonian Misc. Coll., No. 252, pp. 31, 104, (bottom pagination), 1872.
Siphonaria peltoides Carpenter, Dall, Amer. Journ. Conch., Vol. 6, no. 1, p. 37, pl. 4, figs. 11*a*, 11*b*, 1870.
Nacella ? vernalis Dall, Amer. Journ. Conch., Vol. 6, no. 1, p. 37, pl. 4, figs. 11*a*, 11*b*, 1870, in synonymy.
Siphonaria (*Williamia*) *peltoides* Dall, Stearns, Proc. U. S. Nat. Mus., Vol. 16, p. 384, 1893.
Williamia peltoides Carpenter, Dall, Nautilus, Vol. 21, no. 8, p. 86, 1907; ? U. S. Nat. Mus., Bull. 112, p. 67, pl. 15, figs. 10, 12, 1921; ? I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 58, pl. 2, fig. 17, 1927.
? *Williamia vernalis* Dall, U. S. Nat. Mus., Bull. 112, p. 67, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 58, pl. 2, figs. 19*a*, 19*b*, 1927.

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[1] Genera of Shells, *Siphonaria*, 1824; type (Gray, 1847) *S. sipho* Sowerby.

Type specimens: Of *peltoides*, in the Liverpool Collection; of *vernalis*, in the U. S. National Museum ?

Type locality: Cape San Lucas, Lower California, Mexico; Recent.

Pleistocene: Upper San Pedro fauna at Santa Monica, Los Angeles County (T. S. Oldroyd, collection).
Recent: Crescent City, California, to the Gulf of California.

From Carpenter's comparison of this species in "size and shape" with *Ancylus fluviatilis* in the Mazatlan Catalogue and his later description in the Annals and Magazine of Natural History, it seems certain that he was applying a name to the more common of the two California Williamias. Dall (1870) early recognized Carpenter's species, redescribed and figured it, and placed in its synonymy his own manuscript name "*vernalis*." Dall's later attempt to assign Carpenter's specific name to the much rarer form with the elevated, somewhat dilated summit and down-curved apex, appears contrary to the facts and must be rejected. The latter form has no radial color markings, or they are reduced to faint traces near the margin of the aperture. It seems probable that there is but one species, the higher form with hooked apex being merely a morphologic response to the less rigorous habitat on broken shells and small rocks beyond the direct pounding of the surf. The common form, "of the shape and size of *Ancylus fluviatilis*," is found on rocks along the shore as well as on *Lamellaria*. The name *peltoides* Carpenter (not of Dall) must be applied to this form.[1]

ORDER CTENOBRANCHIATA

Superfamily Toxoglossa

Family TEREBRIDAE

Shell long, narrow, solid, many whorled, whorls somewhat flattened; suture shallow; anal fasciole often clearly defined; aperture relatively small; anterior canal short, notched; outer lip sharp; columella with or without one or two twists or low folds; operculum horny, annular, with terminal nucleus.

Geologic range: Cretaceous to Recent.

Distribution: Tropical and warm temperate seas, generally in shallow water on fine sandy bottoms.

Genus **TEREBRA** Bruguière, 1789

Terebra Bruguière, Encyclo. Méth., Hist. Nat. Vers., Vol. 1, p. XV, genus without species, 1789; Lamarck, Mém. Soc. Hist. Nat. Paris, p. 71, 1799, only species *Buccinum subulatum* Linnæus; Tryon, Man. Conch., Vol. 7, pp. 3-8, 1885; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 48, 1896; Dall, Bull. Mus. Comp. Zool., Vol. 43, pp. 245-248, 1908; Woodring, Carnegie Inst., Publ. No. 385, p. 135, 1928.
Terebrum Montfort, Conch. Syst., Vol. 2, pp. 430-432, 1810, type *Buccinum subulatum* Linnæus.

Type (by monotypy, Lamarck, 1799), *Buccinum subulatum* Linnæus, Syst. Nat., Ed. 12, p. 1205, 1767; Indo-Pacific; Recent.

Subgenus **TEREBRA**, s. s.

Shell of large or moderate size, heavy; sculpture generally rather low or absent; columella twisted, often with one or two folds.

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[1] Carpenter (Mazatlan Catalogue, p. 202) thus describes the *Nacella* sp. ind. which he later named *peltoides:* "Tablet 944 contains a solitary specimen of a Nacella, of the shape and size of Ancylus fluviatilis, with the apex spirally recurved, and of a dark horny color. It is not perfect enough for description." The spirally recurved apex is quite variable. All the Williamias have a spiral apex, and the Pacific coast species generally have the apex recumbent downward or merged in the shell surface.

The typical subgenus is represented on the Pacific coast of North America by *Terebra robusta* and *T. strigata*. It appears to be represented in the Miocene of California by *T. cooperi* Anderson[1] from the Temblor formation, middle Miocene of the Kern River region.

Terebra (Terebra) robusta Hinds

Terebra robusta Hinds, Proc. Zool. Soc. London for 1843, p. 149, June, 1844; Hinds, in Sowerby's Thes. Conch., Vol. 1, *Terebra*, p. 152, *ante* Jan. 15, 1845; Reeve, Conch. Icon., Vol. 12, *Terebra*, pl. 3, fig. 10, 1860; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 11, pl. 2, figs. 16, ? 17, ? 25, 1885; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Shell elongated, subulate, turreted, smooth, solid, white, with interrupted longitudinal reddish-brown spots; whorls girdled, but the girdles only visible on the early whorls, the last whorl with three series of markings, suddenly contracted below; aperture elongated, with a short canal; columella arched and covered by a thin callus. Operculum small and thick. Epidermis thicker than is usual. (Hinds, 1845.)

Type locality: West coast of America between 8° 57′ and 21° 32′ north latitude (Hinds).

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Gulf of California, Mexico, to Panama.

It is probable that *T. loroisi* Guerin, not Deshayes, *T. incomparabilis* Deshayes, *T. lingualis* Hinds, and *T. insignis* Deshayes are either synonyms of or very closely related to *T. robusta*. References to these species may be found in Tryon's Manual.

Terebra robusta Hinds differs from *T. strigata* Sowerby in the lack of the sinus bordering the lower margin of the sutural band, or siphonal fasciole, on Hind's species. This linear sinus girdles all the whorls of *strigata* but can only be detected on the early whorls of *robusta*. The whorls of *robusta* are roundly tabulated or shouldered below the suture, which further distinguishes the species from *strigata*.

Hinds reported his species from "Panama, Gulf of Nicoya, Gulf of Papagayo, and San Blas; in from four to eighteen fathoms, sandy mud."

Terebra (Terebra) strigata Sowerby

Terebra strigata Sowerby, Cat. Shells, Tankerville, Appendix, p. XXIII, 1825; Hinds, in Sowerby's Thes. Conch., Vol. 1, p. 151, pl. 41, fig. 10, *ante* January 15, 1845; Reeve, Conch. Icon., Vol. 12, *Terebra*, pl. 2, fig. 5, 1860; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 12, pl. 2, fig. 29, 1885; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 206, 1909.

Terebra elongata Wood, Index Test., Supplement, p. 55, pl. 13, fig. 25, 1828.

Terebra flammea Lesson, Illust. de Zool., pl. 48, 1832, not *T. flammea* Lamarck, Hist. Anim. s. Vert., Vol. 7, p. 284, 1822, East Indies.

Terebra zebra Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 9, "Genre Vis" (*Terebra*), p. 5, pl. 3, fig. 5, 1838-39.

Type locality: Panama, Recent.

Pleistocene: Quaternary deposits at or near Mantua, Ecuador (B. Bryan); Coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Gulf of California and Cape San Lucas to Paita, Peru, and Galapagos Islands (Dall).

This species is large and heavy shelled like *robusta*, but lacks the shoulder on the upper parts of the whorls and has a linear sinus below the suture which is obsolete on *robusta*. Both species lack sculpture, with the exception of fine growth lines and, on the uppermost whorls, fine axial riblets.

In the Stanford University collections there is an incomplete specimen of a fossil *Terebra* labeled "*Terebra strigata* Sby. Mantua, Ecuador, Quaternary, B. Bryan," which appears to be correctly identified.

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[1] Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 203, pl. 16, figs. 66, 67, 1905.

Subgenus **STRIOTEREBRUM** Sacco, 1891

Strioterebrum Sacco, Molluschi dei Terreni Terziarii del Piemonte e della Liguria, Pt. 10, p. 33, 1891; Dall, Nautilus, Vol. 21, p. 249, 1908; Bull. Mus. Comp. Zool., Harvard College, Vol. 43, pp. 246, 248, 1908; Woodring, Carnegie Inst., Publ. No. 385, p. 137, 1928.

"*Myurella* Hinds," Cossmann, Ess. Paléo. Comp., Vol. 2, p. 49, 1896, not of Hinds, in Sowerby's Thes. Conch., Vol. 1, *Terebra*, p. 171, 1845.

Type (by original designation), *Terebra basteroti* Nyst; Mediterranean region, Miocene.

Shell small or medium sized, slender; whorls sculptured with axial ribs and spiral threads or grooves, sutural band generally well defined; aperture rather narrow, anterior canal short, notched, columella generally with a broad basal fold.

Geologic range: Cretaceous to Recent (*fide* Cossmann, "*Myurella*").

Distribution: Tropical and warm temperate seas.

This group is readily differentiated from the large, heavy, typical Terebras, which generally have no sharply-defined sculpture or have merely rounded nodes or low axial ribs. *Strioterebrum* has both axial and spiral ribs; but the spiral ribs are less prominent, generally do not cross the axials, and often are very faint or obsolete.

Hinds proposed *Myurella*[1] for the three species which preceded his subgeneric heading. It is not surprising that this peculiar arrangement has misled many subsequent authors. Cossmann designated *T. affinis* Gray as type, a species that followed but was not included in the original list of species.

Strioterebrum is well represented on both coasts of Mexico and Central America and also in the Miocene of the Caribbean region and of Panama. Some of the Pacific species are so similar to their Atlantic analogues, even to west African shells, that it is a matter of doubt whether they should be considered distinct varieties. The subgenus is largely tropical in distribution and ranges back at least as far as the Eocene.

Terebra (Strioterebrum) variegata Gray

Terebra variegata Gray, Proc. Zool. Soc. London for 1834, p. 61, November, 1834; Hinds, in Sowerby's Thes. Conch., Vol. 1, *Terebra*, p. 173, pl. 43, fig. 53, 1845; Reeve, Conch. Icon., Vol. 12, *Terebra*, pl. 4, fig. 12 (see also pl. 16, figs. 12*b*, 12*c*, 12*d*, 12*e*), 1860; Tryon, Man. Conch., Ser. 1, Vol. 7, pp. 14, 15, in part, pl. 1, figs. 5, 7, pl. 2, figs. 15, 19, pl. 3, fig. 31, 1885; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Lower whorls with spiral grooves or cords; sutural band raised, more or less nodulous; body whorl with a light peripheral band showing as a white line inside the aperture; adult shell stout and over 50 mm. in length; color white to bluish gray, with reddish or brownish interrupted spots. (After A. M. Strong, MS.)

Type locality: Guaymas, Sonora, Mexico (*fide* Hinds).

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).

Recent: Sonora coast of Mexico (Hinds); Scammons Lagoon to the Galapagos Islands (Jordan).

Terebra variegata Gray is well provided with superfluous names which have been omitted here. For a good discussion of the synonymy the reader is referred to Reeve and to Tryon. The species leans toward *Terebra*, *s. s.*

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[1] Type designated by Dall, Bull. Mus. Comp. Zool., Vol. 43, p. 249, 1908, *Terebra myuros* Lamarck.

Terebra (**Strioterebrum**) **specillata** Hinds

Terebra specillata Hinds, Proc. Zool. Soc. London for 1843, p. 155, June, 1844; Hinds, in Sowerby's Thes. Conch., Vol. 1, *Terebra*, p. 163, pl. 44, fig. 96, ? pl. 45, fig. 116, January, 1845; Deshayes, Proc. Zool. Soc. London for 1859, p. 303, 1859; Reeve, Conch. Icon., Vol. 12, *Terebra*, pl. 17, fig. 75, 1860; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 24, pl. 7, fig. 18, 1885; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.
? "*Terebra armillata* Hinds," Reeve, Conch. Icon., Vol. 12, pl. 16, fig. 72*a* only, 1860.

Shell slenderly turreted, very acuminated, whitish, sparingly tessellated with livid flesh color, sutural margin irregularly spotted with red, whorls convexly flattened, everywhere latticed with ridges, divided at the upper part by an impressed groove; aperture rather small, columella straight. (Reeve.)

Type locality: San Blas, State of Tepic, Mexico.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Lower California, Gulf of California, and south to San Blas, Mexico; San Pedro (*fide* Jordan).

Deshayes believed that Hinds' two figures of *specillata* in the Thesaurus Conchyliorum probably represent two species, but the present authors are inclined to disagree with this opinion. One of Reeve's figures (72*a*) of *armillata* may represent *specillata*, but without the type specimens themselves it is difficult to separate these closely related forms. They can hardly be more than varietally distinct. Color markings appear to vary as well as sculpture. Some Terebras in the collection at Stanford University from Scammons Lagoon, Lower California, Mexico, appear to belong to *specillata;* but they are of a uniform purplish-blue color, without white bands, and otherwise resemble *T. albocincta* variety *pedroana*.

T. specillata and its varieties are similar to *T. dislocata* (Say).

Terebra (**Strioterebrum**) **specillata** Hinds variety **armillata** Hinds

Terebra armillata Hinds, Proc. Zool. Soc. London for 1843, p. 154, June, 1844; Hinds, in Sowerby's Thes. Conch., Vol. 1, *Terebra*, p. 173, pl. 43, fig. 49, 1845; Reeve, Conch. Icon., Vol. 12, *Terebra*, pl. 16, fig. 72*b*, ? not fig. 72*a*, = ? *specillata*, 1860; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 14, in syn. of *variegata* Gray, pl. 2, fig. 21, 1885, reproduction of Reeve's figure 72*b;* Dall, Nautilus, Vol. 32, p. 23, 1918.
Terebra albicostata Adams and Reeve, Zool. Voy. Samarang, p. 30, pl. 10, fig. 21, May, 1850.

Shell subulately turreted, brown or livid, obscurely banded and spotted with rust and white, whorls slopingly concave, longitudinally irregularly plicated, spirally ridged and grooved, divided by a groove at the upper part, margin prominent, sometimes strongly obliquely noduled; aperture oblong, columella twistedly recurved. (Reeve.)

Type locality: Between Panama and Magdalena Bay, Mexico; Galapagos ?.

Pleistocene: Magdalena Bay, Lower California, Mexico (Hinds; Dall).
Recent: Lower California, Mexico, to Panama; Galapagos ?.

Of Reeve's two figures, 72*b* represents a shell from Panama and 72*a* looks very much like *specillata*. The shells from Panama should be considered as coming from the typical habitat of *armillata* until it can be shown that the Galapagos shell is identical. In regard to habitat, Hinds stated:

> "Abundant in various localities on the west coast of America between Panama and the Bay of Magdalena in Lower California, in from five to thirteen fathoms; also at the Galapagos, in ten fathoms: chiefly in sandy situations. It was also found imbedded in the fossiliferous cliffs which surround a portion of the Bay of Magdalena."

In the collection at Stanford University there are several specimens of *Terebra* about two inches long reputed to have come from San Pedro that approach in character the common *T. dislocata* Say from Florida. They have moderately numerous axial ribs and four to six spiral riblets between the anal fasciole and the lower suture. The sutural band is moderately broad, with well-developed, axially elongate nodes. The band is whitish and there is a white band inside the outer lip in the place where the anal fasciole of the next whorl will come. The remainder of the shell is buff colored. One specimen is almost identical with the true *dislocata* and may be an adventitious specimen. Another has a prominent sutural band like *armillata*. When such apparently anomalous variants occur in a comparatively small series of specimens, it is suggested that it would be beneficial to synonymize a considerable number of supposed specific names and, ignoring the unusual variants, to base those names which have some chance of representing valid distinctions upon the average characters of a large number of specimens. Much more critical study of larger collections than are now available is needed before the true species and varieties of the *dislocata* clan can be authoritatively described. It is almost certain that there are too many names.

Terebra (Strioterebrum) dislocata (Say)

Cf. Plate 24, Figure 19

Cerithium dislocatum Say, Journ. Acad. Nat. Sci. Phila., Vol. 2, p. 235, July, 1822.

Terebra rudis Gray, Proc. Zool. Soc. London for 1834, p. 60, 1834.

Terebra petitii Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 9, "Genre Vis" (*Terebra*), p. 37, pl. 13, fig. 32, 1838-39.

Terebra dislocata Say, Tuomey and Holmes, Post-Pleiocene Foss. So. Carolina, p. 70, pl. 11, fig. 12, 1858; Reeve, Conch. Icon., Vol. 12, *Terebra*, pl. 9, fig. 32, 1860; Tryon, Man. Conch., Ser. 1, Vol. 7, pp. 18, 19, in part, pl. 4, figs. 63-65, 69, 1885.

Terebra (*Acus*) *dislocata* Say, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 24, 1890.

? "*Terebra gausapata* Brown and Pilsbry," Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 455, pl. 22, figs. 4, 5, 1926, questionably of Brown and Pilsbry, Proc. Acad. Nat. Sci. Phila., Vol. 63, p. 340, pl. 22, figs. 8, 9, 1911, Miocene of the Canal Zone.

Type locality: Atlantic coast between Maryland and Florida; Recent.

Miocene: Virginia, North Carolina, etc. (*fide* Dall, as *dislocata*).
Pliocene: The Carolinas and Florida, etc. (*fide* Dall, as *dislocata*); ? Coyote Mountain, Imperial County, California (Hanna, as *gausapata*).
Pleistocene: "The whole coast from Maryland southward" (Dall, as *dislocata*); ? loc. 249, S. D. S. N. H., lower Pleistocene of Ventura, California (U. S. G.).
Recent: Maryland south to Florida; Bahamas and Venezuela (Dall, 1890).

We have questionably assigned Hanna's record of *Terebra gausapata* Brown and Pilsbry, from the Coyote Mountain Pliocene, to *T. dislocata* Say. In the Oldroyd Collection at Stanford University there are specimens of *dislocata* from the Atlantic coast, some variants of which seem so similar to Hanna's figures of the Coyote Mountain shell that we do not see how they can be reasonably separated. *T. gausapata* Brown and Pilsbry, according to the type figures, appears to differ from Hanna's specimen in the possession of rounded nodes on the anal fasciole between the upper ends of the axial ribs, not in line with these ribs nor even just slightly offset as on many Recent specimens of the *dislocata* clan.

In 1890 Dall reported *T. dislocata* from the Miocene to Recent along the Atlantic coast and, as variety *tantula* Conrad, from the Mississippi Eocene. While this great range might require an unreasonable stretching of the specific limits of the Recent species, it seems that little addition to our knowledge of the group has resulted since that time by the numerous descriptions, as distinct species, of very similar forms based upon an inadequate number of specimens. If a long-ranging, warm-temperate form like *T. dislocata* is known to have lived along the Atlantic coast in the Miocene, when the Atlantic and Pacific were connected, it is not so surprising to find that form in the Pliocene or the Recent of the Pacific coast as well as in the later fossil and Recent record of the Atlantic.

Terebra (Strioterebrum) albocincta (Carpenter)

Myurella albocincta Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., pp. 384, 385, 1857.
Terebra (*Myurella*) *albocincta* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 258, 1857.

Adult shell slender, less than 50 mm. in length; lower whorls with four or five spiral grooves; axial ribs distinct on early whorls only; sutural band raised, more or less nodulous; body whorl with a light peripheral band showing as a white line inside the aperture; color purplish brown to olivaceous, sutural band whitish. Average measurements: Length, 40 mm.; diameter, 8.5 mm. (After A. M. Strong, MS.)

Type locality: Mazatlan, Mexico; Recent.

Recent: Gulf of California and west coast of Mexico.

T. subnodosa Carpenter is probably a synonym of this species.

Terebra (Strioterebrum) albocincta (Carpenter) variety **hindsii** (Carpenter)

Plate 32, Figure 35

Myurella hindsii Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., pp. 385, 386, 1857.
"*Terebra larvæformis* Hinds," E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; not of Hinds, 1844.

Shell like that of *T. albocincta* Carpenter, but with the axial ribs obsolete and the spiral grooves strong; color whitish, faintly spotted with reddish brown. Measurements: Length, 31 mm.; diameter, 7 mm. (After A. M. Strong, MS.)

Type locality: Mazatlan, Mexico; Recent.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan, as *T. larvæformis* Hinds).
Recent: Gulf of California, Mexico, to Panama.

Mr. A. M. Strong examined the specimen upon which Jordan based his Pleistocene record and pronounced it *T. hindsii*. It is a doubtfully valid variety of *albocincta*.

As pointed out by Reeve, many of the west African Terebras have characters and variations almost identical with those of species found along the Pacific coast of the Americas. In the absence of a good figure of *hindsii*, Reeve's figure of *T. intertincta* Hinds from west Africa might be used for ordinary identifications (Conch. Icon., Vol. 12, *Terebra*, pl. 16, fig. 12*c*, 1860).

Terebra (Strioterebrum) albocincta (Carpenter) variety **pedroana** Dall

Plate 24, Figures 18, 24

Myurella simplex Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 657, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 395, 1865; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 78, 1868-69; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 253, 1888; Keep, West Coast Shells, p. 56, fig. 40, 1888, 1892; not of Conrad, 1830.
Terebra (*Acus*) *simplex* Carpenter, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 207, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 198, 1903.
Terebra (*Strioterebrum*) *pedroana* Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, p. 251, 1908.
Strioterebrum pedroanum Dall, Bull. 112, U. S. Nat. Mus., p. 67, February 24, 1921.
Strioterebrum pedroanum philippianum Dall, Bull. 112, U. S. Nat. Mus., p. 67, 1921, not *Terebra philippiana* Deshayes, 1859.
Terebra (*Strioterebrum*) *pedroana* Dall, Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 59, pl. 6, fig. 6, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.
Terebra (*Strioterebrum*) *pedroana philippiana* Dall, Oldroyd, *op. cit.*, p. 60, 1927.
Terebra pedroana Dall, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 252, 1929.
Terebra pedroana philippiana Dall, E. K. Jordan, *op. cit.*, p. 245, 1926.

Shell like that of *T. albocincta* (Carpenter), but with the sutural band nodulous on the early whorls only; axial ribs low and distinct or reduced to mere lines of growth; color bluish white to yellowish brown, irregularly blotched. Size: Length, 32 mm.; diameter, 6.5 mm. (After A. M. Strong, MS.)

Type specimens: Of *pedroana* and of *philippiana*, in the U. S. National Museum.

Type localities: Of *pedroana*, San Pedro, California, Recent; of *philippiana*, new name for *simplex* Carpenter, Santa Barbara, California, Recent.

Pliocene: San Diego well (Dall).
Pleistocene: Rare in "Pliocene" of Deadman Island and Timm's Point, San Pedro; Barlow Canyon, just east of Ventura (Arnold); "Saugus" near Ventura (Waterfall); rare in lower San Pedro series of San Pedro region; foot of Twenty-sixth Street, Spanish Bight, and Pacific Beach, San Diego (Arnold); Spanish Bight, San Diego (F. Stephens); palisades at Santa Monica (coll. by F. C. Clark); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Barbara, California, to the Gulf of California, Mexico.

The variety *philippiana* is supposed to be distinguishable from *pedroana* by its less distinctly developed axial ribs.

Terebra (Strioterebrum) elata Hinds

Terebra elata Hinds, Proc. Zool. Soc. London for 1843, p. 156, June, 1844; Hinds, in Sowerby's Thes. Conch., Vol. 1, *Terebra*, p. 177, pl. 44, figs. 68, 69, January, 1845; Reeve, Conch. Icon., Vol. 12, pl. 24, fig. 128, 1860; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 21, pl. 5, fig. 82, 1885.

? "Terebra protexta Conrad," Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 456, 1926, questionably of Conrad, 1846.

Shell somewhat like that of *albocincta*, but smaller, with the axial ribs and spiral grooves distinct on all whorls; color reddish white, red banded at base. Size: Length, 25 mm.; diameter, 5 mm.

Type locality: "Bay of Montijo, west coast of America; in fifteen fathoms, coarse sand." (Hinds.)

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Pacific coast of Central America and Panama.

Terebra elata Hinds has much more distinct sculpture than *T. albocincta* and its varieties. Generally it is a smaller shell.

Hanna's report of *Terebra protexta* (Conrad)[1] from the Pliocene of the Carrizo Creek region was based upon a poorly preserved specimen which we suggest may have been *T. elata* Hinds. The latter is a Recent Central American shell similar to Conrad's species but with a more definitely delimited sutural band. *T. protexta* ranges from Florida to Vera Cruz,[2] Mexico.

Terebra (Strioterebrum) elata Hinds variety **martini** English

Terebra martini English, Univ. Calif. Publ. Geol., Vol. 8, p. 216, pl. 23, fig. 3, November 7, 1914.

Shell like that of *T. elata* Hinds but without spiral sculpture.

Type specimen: In the University of California collection.

Type locality: Holser Canyon, Los Angeles County; middle Pliocene.

Pliocene: Middle Pliocene of Holser Canyon, north of Santa Clara Valley, Los Angeles County, S. D. S. N. H. locality 217*b* (H. R. Gale, collector; type locality, English); San Diego formation at Balboa Park, San Diego (Hertlein and Grant, MS.).

This variety is characterized by the numerous, sharp, axial ribs and the absence of spiral striæ or threads. The sub-sutural band is prominent. So far as known, it occurs only in the middle Pliocene of the upper Santa Clara Valley and of the San Diego region. It is probably entirely different from *T. cooperi* Anderson, with which English compared it.

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[1] *Cerithium protextum* Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 3, p. 26, February, 1846, "Locality. Tampa Bay?"; Tryon, Man. Conch., Ser. 1, Vol. 7, *Terebra*, p. 25, pl. 6, fig. 98, 1885.

[2] F. C. Baker, Proc. Acad. Nat. Sci. Phila. for 1891, p. 49.

Family CONIDAE

Genus CONUS Linnæus, 1758

Conus Linnæus, Syst. Nat., Ed. 10, p. 712, 1758; Montfort, Conchyl. Syst., Vol. 2, p. 406, type cited *Conus generalis* Linnæus; Children, Quart. Journ. Sci., Lit., Arts, Vol. 16, p. 69, pl. 5, fig. 208, October, 1823, type cited *Conus marmoreus* Linnæus; Weinkauff, Jahrb. Deutsch. Mal. Gesell., Vol. 1, 1874; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 7, 1884; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 152, 1896; Woodring, Carnegie Inst., Publ. No. 385, p. 201, 1928.

Rhombus Montfort, Conchyl. Syst., Vol. 2, p. 402, 1810, type *Rhombus imperialis* = *Conus imperialis* Linnæus.

Type (by subsequent designation, Children, 1823), *Conus marmoreus* Linnæus, figured by Reeve, Conch. Icon., Vol. 1, *Conus*, sp. 74, pl. 14, fig. 74, 1843; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 7, pl. 1, fig. 1, 1884; Indo-Pacific, Recent.

Shell heavy, conical, with a very low to moderately elevated spire: aperture long and narrow, nearly or entirely the length of the body whorl; outer lip simple, sometimes sharp; no lirations or denticulations on inner lip; anterior canal a mere siphonal notch; posterior notch very shallow or deep; sculpture generally low or consisting of spiral striations, which are often concentrated on the lower part of the body whorl, and nodes, beads, or blunt spines on the shoulders of the whorls; epidermis thin; operculum with apical nucleus.

Geologic range: Cretaceous to Recent.

Distribution: Tropical and warm temperate seas.

The cones form a very natural and readily recognizable group. *Parametaria* Dall, of the *Pyrenidæ* is similar in appearance to *Conus*, but can be distinguished by the lirations or denticulations on the inside of the outer lip. *Parametaria* is a small, comparatively rare genus.

A number of names have been proposed for subdivisions of *Conus*, but many of these have very doubtful systematic value. Woodring has concluded that differences of shape and sculpture cannot be used for a satisfactory subdivision of the genus, and he therefore makes use of the characters of the anterior canal, siphonal fasciole, outer lip, and anal fasciole in grouping the cones of the Miocene deposits of Bowden, Jamaica. An attempt to arrange the Recent cones in the Oldroyd Collection at Stanford University by means of these apertural characters seemed unsatisfactory, and we have, therefore, omitted any subgeneric or sectional distinction in listing the fossil cones. It is true, however, that there are several minor groups of *Conus* which are certainly distinctive and entitled to sectional or subgeneric rank, such as *Rollus*, *Rhombus*, and *Hermes* Montfort,[1] but they are not represented in the fossil faunas considered in this report.

Many Recent species or varieties of *Conus* have been based largely on color differences, which are nearly always obliterated in fossilization. Fossil specimens not displaying these color characteristics should be identified with the earliest named species of the region bearing the same morphologic features. In some cases the identity must be purely conjectural.

Dall has published a brief paper[2] on the Recent Pacific coast species of *Conus;* but his suggested synonymy is not always compatible with the literature, and his later identifications as displayed by museum labels are in part at variance with his published conclusions.

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[1] Conchyl. Syst., Vol. 2, 1810, types, respectively, *C. geographus* Linnæus, *C. imperialis* Linnæus, and *C. mussatellus* Linnæus, by original designation.

[2] Proc. U. S. Nat. Mus., Vol. 38, pp. 217-228, 1910.

Conus californicus Hinds

Plate 24, Figure 21

Conus californicus Hinds, Zool. Voy. Sulphur, Vol. 2, p. 7, pl. 1, figs. 3, 4, 5, 1844; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 78, 1868-9; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 17, pl. 4, figs. 62, 63, 1884; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 236, 1888; Keep, West Coast Shells, p. 54, 1888, 1892; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 171, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 199, 1903; Keep, West American Shells, p. 156, fig. 139, 1904; Dall, Proc. U. S. Nat. Mus., Vol. 38, p. 220, 1910; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Dall, Bull. 112, U. S. Nat. Mus., p. 68, pl. 14, fig. 9, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, no. 7, p. 245, 1926; Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 49, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 61, 1927.

Conus ravus Gould, Boston Journ. Nat. Hist., Vol. 6, pp. 386-7, pl. 14, fig. 21, April, 1852; Otia Conch., p. 187, 1862.

Shell rather small, pyriform, with a rounded or bluntly angulated shoulder and moderately elevated spire; sculpture consisting of fine spiral threads on the lower part of the body whorl and sometimes a few faint striations on the whorls of the spire; living specimens of a white or bluish-white color, with or without faint brownish reticulations; periostracum brown. Average adult specimens 30 to 35 mm. in length.

Type specimen: Of *californicus*, in the British Museum ?.

Type localities: Of *californicus*, Magdalena Bay, Lower California, Mexico, "in seven fathoms, on a sandy floor" (Hinds); of *ravus* Gould, Santa Barbara, California, Recent.

Pliocene: San Fernando (Cooper); "Lower Fernando" of Elsmere and Holser canyons, Los Angeles County (English); Fernando Pliocene of Puente Hills, Orange County (Carson, 1926); S. D. S. N. H. loc. 203, one specimen, and 207, eight specimens, both lower Pliocene of Elsmere Canyon, Los Angeles County (H. R. Gale, coll.); S. D. S. N. H. locs. 216 and 216*a*, lower Pliocene east of Fernando Pass, two specimens (H. R. Gale, coll.); S. D. S. N. H. loc. 227, lower Pliocene southwest of Humphreys station, Los Angeles County, several small casts (H. R. Gale, coll.); S. D. S. N. H. locs. 217*a* and 217*b*, middle Pliocene near Holser Canyon, Los Angeles County, two small specimens (H. R. Gale, coll.); S. D. S. N. H. loc. 221, middle Pliocene east of Cañada de Aliso, Ventura County, one specimen (H. R. Gale, coll.); S. D. S. N. H. loc. 222, middle Pliocene at head of Cañada de las Encinas, Ventura County, one specimen (H. R. Gale, coll.); S. D. S. N. H. loc. 219, Sexton Canyon shale, upper Pliocene, Ventura County; upper Pliocene of Deadman Island and Timm's Point, Los Angeles County (Arnold, 1903).

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (E. K. Jordan); lower San Pedro fauna of Nob Hill cut, San Pedro, "plentiful" (T. S. Oldroyd); S. D. S. N. H. loc. 242, Adams Canyon, Ventura County; L. S. J. U. loc. 275, two miles north-northeast of Santa Paula, Ventura County; L. S. J. U. loc. 237, "Saugus" Pleistocene of Adams Canyon, Ventura County; Pleistocene of Spanish Bight and Pacific Beach, San Diego County; upper San Pedro series at Deadman Island, Crawfish George's, Los Cerritos, San Pedro, and Long Beach, Los Angeles County, common (R. Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926).

Recent: Farallone Islands, California, to Ballenas Lagoon, Lower California, Mexico (Dall).

This, the only species of *Conus* in the Recent fauna of California, is recognizable by its lack of prominent sculpture, its rounded shoulder, and its small size. The anterior canal is slightly curved backward, producing a somewhat constricted appearance near the base of the body whorl. The variety *fossilis* T. S. Oldroyd is larger and has a higher spire, but is probably not of significance.

Conus californicus Hinds variety **fossilis** T. S. Oldroyd

Conus californicus fossilis T. S. Oldroyd, Nautilus, Vol. 34, no. 4, p. 116, pl. 5, fig. 9, April, 1921; Proc. U. S. Nat. Mus., Vol. 65, p. 10, 1924.

Type specimen: In the Oldroyd Collection, Stanford University.

Type locality: Nob Hill, San Pedro, Los Angeles County; lower Pleistocene.

Pleistocene: Lower and upper San Pedro beds of San Pedro region, Los Angeles County (Oldroyd); Pleistocene of Spanish Bight, San Diego County (Mrs. Kate Stephens MS.).

This form differs from the typical in the more elongate shape and greater proportionate distance between the shoulder of the body whorl and the apex of the spire. It occurs in the Pleistocene, where it is less common than the normal form with which it appears to intergrade. Some Recent specimens appear to agree in characters with *fossilis*, and it is almost certain that the form *fossilis* is represented merely by unusually healthy or aged individuals of the normal form and that therefore the name should be synonymized.

Conus fergusoni Sowerby

? *Conus coelebs* Hinds, Ann. Mag. Nat. Hist., p. 256, 1843, *fide* Dall, 1910.

? *Conus haytensis* Sowerby, Quart. Journ. Geol. Soc. London, Vol. 6, p. 44, 1850, *fide* Hanna, 1926.

Conus fergusoni Sowerby, Proc. Zool. Soc. London for 1875, p. 145, pl. 15, fig. 1; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 15, pl. 4, fig. 52*a*, 1884; Stearns, Proc. U. S. Nat. Mus., Vol. 16, p. 386, 1893; Dall, Vol. 37, p. 207, 1909; Vol. 38, p. 218, 1910; Dall, Nautilus, Vol. 32, p. 23, 1918; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 446, pl. 21, figs. 6, 7, 1926.

? *Conus mollis* Brown and Pilsbry, Proc. Acad. Nat. Sci. Phila., p. 343, pl. 23, fig. 1, 1911.

Type locality: Panama, Recent.

Miocene: ?
Pliocene: Imperial formation, Coyote Mountain, Imperial County, California (Hanna).
Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918).
Recent: Magdalena Bay, Lower California, Mexico, to Ecuador and Galapagos Islands (Dall, 1910).

This is a large, white species, rather broad at the shoulder and lacking conspicuous sculpture. The width at the shoulder is three-fifths or more of the axial length. The spire is low.

Should *C. coelebs* Hinds, 1843, be proved to be the young of *C. fergusoni*, as suggested by Dall, the later name will become a synonym. Hanna has pointed out the possibility of *C. haytensis* Sowerby and *C. mollis* Brown and Pilsbry being conspecific with *fergusoni*. *C. mollis* occurs in the Gatun formation, middle Miocene of Panama.

Conus gladiator Broderip

Conus gladiator Broderip, Proc. Zool. Soc. London, p. 55, 1833; Reeve, Conch. Icon., Vol. 1, *Conus*, sp. 127, 1843; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 28, pl. 8, fig. 38, 1884; Stearns, Proc. U. S. Nat. Mus., Vol. 16, p. 386, 1893 (erroneously as of Sowerby); Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 170, 1894; Dall, Vol. 38, p. 221, 1910.

"Spire rather depressed, tuberculate, and striate; color chocolate-brown, variegated with white, disposed in longitudinal streaks, with an irregular white band, and more or less distinct revolving lines of darker brown; interior white or tinged with chocolate; epidermis fibrous. Length, 1.25-1.75 inches." (Tryon.)

Pleistocene: Upper Pleistocene of the coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Gulf of California to the Galapagos Islands (Dall).

This species appears to be very closely related to *C. brunneus* Gray,[1] from which it is said to differ by the finer coronation on the upper portion of the shell.

Conus lucidus Mawe in Wood

Conus lucidus Mawe, Wood's Index Test., Suppl., pl. 3, fig. 4, 1828; Stearns, Proc. U. S. Nat. Mus., Vol. 16, p. 385, 1893; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 207, 1909; Vol. 38, p. 226, 1910; Dall, Nautilus, Vol. 32, p. 23, 1918.

Conus reticulatus Sowerby, Conch. Illust., *Conus*, p. 3, part and plate 57, fig. 86, 1833; not *Conus reticulatus* Martini, Neues Syst. Conch. Cab., Vol. 2, p. 261, pl. 56, figs. 619-621, 1773.

"*Conus puncticulatus* Hwass" E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; not of Hwass, 1792.

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[1] Wood's Index Test., Supplement, pl. 3, fig. 1, 1828. Some of the names were taken from the MSS. of John E. Gray, *fide* "Catalogue of the Books, Manuscripts, Maps and Drawings in the British Museum (Natural History)," Vol. 5, p. 2353, 1915.

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Dall, 1918; one specimen in the collection at Stanford Univ.); upper Pleistocene, coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Magdalena Bay, Lower California, Mexico, to the Galapagos Islands (Dall, 1910).

This is a rather short, broad species with low, evenly conical spire and handsome brown, reticulated color markings on a white background. Sculpture is practically absent.

Conus reticulatus Sowerby, 1833, is unquestionably conspecific. In the Stanford collections there is one specimen labeled *Conus puncticulatus* Hwàss from the Quaternary of Magdalena Bay which retains faintly the color markings of *C. lucidus*. According to Dall, *Conus puncticulatus* Hwass was distinctly assigned to the West Indies by the original describer, and west Mexican specimens assigned to *puncticulatus* by other authors Dall refers to *Conus comptus* Gould, 1851, an identification that is puzzling if the habitat (Santa Barbara) given by Gould is correct.

Conus mahogani Reeve

Conus interruptus Broderip and Sowerby, Zool. Journ., Vol. 4, p. 379, 1829; not *C. interruptus* Mawe, 1828.
Conus mahogani Reeve, Conch. Icon., Vol. 1, *Conus*, sp. 126, pl. 22, fig. 126, Aug., 1843; Proc. Zool. Soc. London for 1843, p. 169, 1844; Dall, Proc. U. S. Nat. Mus., Vol. 38, p. 219, 1910.
Conus interruptus Broderip, Tryon, Man. Conch., Ser. 1, Vol. 6, p. 63 (in part), pl. 27, fig. 8, 1884.

"Shell elongately turbinated, rather cylindrical, grooved towards the base; whitish, profusely stained with reddish brown and encircled with numerous fillets of the same color articulated with white; spire very much raised; interior white." (Reeve.)

Type localities: Of *C. mahogani* Reeve, Salango, West Colombia; of *C. interruptus* Broderip and Sowerby, near Mazatlan.

Pleistocene: Upper Pleistocene, west coast of Oaxaca, Mexico, on the Gulf of California (coll. by R. H. Palmer).
Recent: Magdalena Bay, Lower California, Mexico, to Panama.

C. catenatus Sowerby, 1878, may be a variety of this species. The specific name is preoccupied by *C. catenatus* Sowerby, 1850,[1] but until the west coast species of *Conus* are thoroughly reviewed, additional names are more of a hindrance than a help.

Conus purpurascens Broderip

Conus purpurascens Broderip, Proc. Zool. Soc. London for 1833, p. 54; Stearns, Proc. U. S. Nat. Mus., Vol. 16, p. 387, 1893; Vol. 17, p. 170, 1894; Dall, Vol. 37, p. 207, 1919; Vol. 38, p. 219, 1910; Nautilus, Vol. 32, p. 23, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Type locality: Panama, Recent.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Dall, 1918; Jordan, 1924); upper Pleistocene, coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Magdalena Bay, Lower California, Mexico, and the Gulf of California to Paita, Peru.

This is a moderately large cone, with a rather low, conical spire. The body whorl is widest just below the shoulder. The sculpture consists of strong growth lines and low, widely spaced, spiral threads on the lower part of the body whorl, becoming obsolete near the middle. The color of Recent specimens is a purple mixed with brown, maculated with white or light pink. It is quite variable in its coloring and markings. Specimens 80 or 90 mm. in length are common.

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[1] Quart. Journ. Geol. Soc. London, Vol. 6, p. 45, pl. 9, fig. 2, 1850. Caribbean Miocene, *fide* Woodring, Carnegie Inst., Publ. No. 385, pp. 213, 214, 1928.

Conus planiliratus Sowerby

Conus planiliratus Sowerby, Quart. Journ. Geol. Soc. London, Vol. 6, p. 44, 1850; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 447, 1926; Woodring, Carnegie Inst., Publ. No. 385, p. 210, pl. 10, figs. 7, 8, 9, pl. 11, figs. 1, 2, 1928.

Not *Conus planiliratus* Sowerby, Proc. Zool. Soc. London for 1870, p. 255, = *C. maculospira* Pilsbry, Proc. Acad. Nat. Sci. Phila., Vol. 73, p. 329, 1922, new name.

? Conus stimpsoni Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 503, pl. 29, fig. 7, 1902.

Type specimen: Of *planiliratus,* in the British Museum, *fide* Woodring.

Type locality: Dominican Republic, Miocene.

Miocene: Middle Miocene of the Dominican Republic; Gatun formation (middle Miocene) of Panama and Costa Rica (Woodring, 1928).

Pliocene: Limon, Costa Rica (Woodring); ? Pliocene of Coyote Mountain, in a branch of Alverson Canyon, Imperial County (identified questionably by Hanna).

? Recent: As "*Conus stimpsoni*" Dall, off Key West, Florida.

This species has been well figured and described by Woodring. The spiral sculpture which may be either strap-like or consist of rather widely spaced rounded cords is characteristic. Hanna, working with poorly preserved material from the Imperial formation of western Imperial County (Pliocene), questionably identified some specimens of *Conus* with this species.

Conus stimpsoni Dall is either conspecific with *C. planiliratus* Sowerby, 1850, or very closely related, as indicated by Woodring.

Conus princeps Linnæus

Conus princeps Linnæus, Syst. Nat., Ed. 10, p. 713, 1758; Reeve, Conch. Icon., Vol. 1, *Conus,* sp. 36*a*, pl. 7, fig. 36*a*, 1843; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 29, pl. 8, fig. 42, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 207, 1909; Vol. 38, p. 224, 1910.

Conus regius Chemnitz, Neues Syst. Conch. Cab., Vol. 10, p. 15, pl. 138, fig. 1276, 1788.

Pleistocene: Coast of Oaxaca, Mexico (coll. by R. H. Palmer).

Recent: Cape San Lucas, Lower California, Mexico, to Panama (Dall, 1910) and south to Paita, Peru (Dall, 1909).

This is a handsome, low-spired species, of a pinkish or orange ground color with wavy, irregular dark brown axial lines. The shoulder of the body whorl and the whorls of the spire have rather evenly-spaced, low, rounded nodosities. According to Dall, *Conus lineolatus* Valenciennes[1] is the variety with the axial stripes reduced to brown hair lines. The variety without the axial stripes Dall has named *apogrammatus.*[2] In the Stanford collections there is one small cone from the Pleistocene along the coast of Oaxaca, Mexico, collected by R. H. Palmer, which appears to belong to this species.

Conus scalaris Valenciennes

Conus scalaris Valenciennes, Voy. Rég. Équinox. Nouv. Cont., Humboldt et Bonpland, Pt. 2, Zool., Vol. 2, liv. 14, p. 338, 1832; Sowerby, Thes. Conch., Vol. 3, *Conus,* p. 14, pl. 9, fig. 192, 1857; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 35, pl. 10, fig. 83, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 38, p. 221, 1910; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 154, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

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[1] Voyage aux Régions Équinoxiales du Nouveau Continent, fait en 1799-1804, etc., by F. H. A. von Humboldt and A. J. A. Bonpland, Atlases and 24 vols. (of the complete work), 4° and folio, Paris, 1805-37; Part 2, Zoology, Vol. 2, Coquilles, by A. Valenciennes. *Conus lineolatus* Valenciennes is presumably described on pp. 336-7 of Vol. 2, liv. 14, issued in 1832. We have not seen this work. For brief collation and dates of issue of the various livraisons of the "Observations de Zoologie," see the note by C. Davies Sherborn, Ann. and Mag. Nat. Hist., Ser. 7, Vol. 3, no. 17, p. 428, May, 1899.

[2] Proc. U. S. Nat. Mus., Vol. 38, p. 224, 1910, type locality, Panama. Reeve, Conch. Icon., Vol. 1, *Conus,* pl. 7, fig. 36*c*, represents this variety. Variety *lineolatus* is represented by fig. 36*b*. *Conus regius* Chemnitz, as figured by that author, is nearest to Reeve's fig. 36*a*. We have not seen Valenciennes' description nor figure.

"Spire elevated, gradate, maculated with chestnut; body whorl somewhat acuminate below; yellowish white with brown-chestnut longitudinal strigations, scarcely interrupted for a narrow central white band, and replaced towards the base by a few revolving rows of chestnut markings. Length 3 inches." (Tryon.)

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Scammons Lagoon and Cedros Island, Lower California, to Gulf of California, Mexico.

Tryon figures a shell with a very sharply defined shoulder and an elevated, subturreted spire. His figure is taken from Sowerby. We have not had access to the original description.

Conus regularis Sowerby is certainly very close to *C. scalaris* Valenciennes and may prove to be conspecific.

Conus regularis Sowerby

Conus regularis Sowerby, Conch. Illust., *Conus*, p. 2, part and pl. 36, fig. 45, 1841; Thes. Conch., Vol. 3, *Conus*, pp. 16, 17, pl. 9, figs. 208-210, 1857; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 37 (in part), pl. 11, figs. 99, 100, 1884; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 171, 1894; Dall, Vol. 38, pp. 221, 222, 1910; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 154, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 447, pl. 21, fig. 8, 1926; Jordan and Hertlein, Vol. 15, p. 419, "*Conus* aff. *C. regularis* Sowerby," 1926; Hanna and Hertlein, Vol. 16, p. 142, 1927.
? "*Conus recurvus* Brod." Kiener, Spéc. Gén. et Icon. Coq., Vol. 2, *Conus*, pl. 97, figs. 4, 4*a*, 1845-46; p. 132, 1847.
Conus beali Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 49, pl. 11, fig. 2, 1926.

Shell moderately elongate; spire elevated, subturreted, anal fasciole slightly concave, ascending at the suture on previous whorl; body whorl elongate, profile not quite rectilinear, a very slight convexity above the middle and a very slight constriction toward the base; shoulder abruptly rounded; sculpture consisting of very low, closely and evenly spaced spiral cords on the basal portion of the body whorl, lacking on the shoulder and spire. (Height of the type of *C. beali* Carson, 64 mm. incomplete; width, 32 mm.)

Type specimen: Of *beali*, in the type collection at Stanford University.

Pliocene: Lower (or middle) Pliocene of the Puente Hills, Orange County, California (Carson; type locality of "*Conus beali*"); (?) Imperial formation, Imperial County, California (G. D. Hanna); Coronados Island and Carmen Island, Gulf of California, Mexico (Hanna and Hertlein); ? Elephant Mesa, near Turtle Bay (south of Scammons Lagoon), Lower California, Mexico (Jordan and Hertlein, as "*Conus* aff. *C. regularis* Sowerby").
Pleistocene: Coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Scammons Lagoon, Lower California, and the Gulf of California, Mexico, to Panama.

This species, as figured by Sowerby in the Conchological Illustrations, is a shell of medium size with a nearly rectilinear body-whorl profile, a moderate spire, which is concave in profile and somewhat turreted, and a color pattern consisting of dark brown or chocolate maculations on a white or light brown ground, the arrangement of the maculations being spiral with vertical interruptions. Specimens in the Oldroyd Collection at Stanford University from the Gulf of California agree well with Sowerby's figure. A specimen of average size has the following measurements: length, 51 mm.; width, 27 mm.; height of spire from shoulder of body whorl, 12 mm.

It is quite possible that *Conus regularis* Sowerby is conspecific with *C. scalaris* Valenciennes, but not having the original description of the latter species, we hesitate to make any change. The "*Conus recurvus* Brod." of Kiener is very close and may be a synonym. *Conus beali* Carson is inseparable from large Recent specimens of *regularis*, and is a very close synonym. Carson called attention to the occurrence of this warm-water species in the Puente Hills Pliocene. *Conus floridanus* Gabb[1] is the Atlantic analogue of *C. regularis*.

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[1] Amer. Journ. Conch., Vol. 4, p. 195, pl. 15, fig. 4, 1868; Recent range from Florida to Cape Hatteras; Pliocene of Florida, *fide* Dall. Trans. Wagner Inst. Sci., Vol. 3, p. 27, 1890.

The specimen from the Pliocene of Coyote Mountain, figured by Hanna, appears to have a much lower spire and more rounded shoulder on the body whorl than any variations of Recent *Conus regularis* we have seen. It is certainly far from typical and may belong to a different species.

Conus tornatus Broderip

Conus tornatus Broderip, Proc. Zool. Soc. London for 1833, p. 53, 1833; Sowerby, Conch. Illust., *Conus*, p. 2, part and pl. 29, fig. 25, 1833; Reeve, Conch. Icon., Vol. 1, *Conus*, sp. 68, pl. 13, fig. 68, 1843; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 63 (in part; in syn. of *C. interruptus* Brod.), pl. 20, fig. 4, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 207, 1909; Vol. 38, p. 219, 1910; Nautilus, Vol. 32, p. 23, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918; E. K. Jordan).
Recent: Cedros Island, Lower California, the Gulf of California, Mexico, south to Ecuador.

This species has a high, turreted spire, which, according to Reeve, distinguishes it from *C. interruptus* Broderip (not Mawe). It appears to have a more elongate body whorl than *C. arcuatus* Sowerby. The latter species has a strongly curved outer lip, with a deep anal notch.

Conus ximines Gray

Conus ximines Gray, Zool. Beechey's Voyage, p. 119, pl. 33, fig. 2, 1839; Tryon, Man. Conch., Ser. 1, Vol. 6, p. 63 (as synonym of *C. interruptus* Broderip), pl. 19, fig. 100, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 207, 1909; Vol. 38, p. 220, 1910; Dall, Nautilus, Vol. 32, p. 23, 1918.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918).
Recent: Gulf of California, Mexico, to Sechura Bay, Peru.

Conrad considered *Conus ximines* Gray a synonym of *C. interruptus* Broderip, and this latter species, according to Dall, is a synonym of *Conus mahogani* Reeve. Dall, however, in his 1910 paper, retains *ximines* as valid. We have not seen the original description nor authentic specimens of this species.

Conus vittatus Hwass

Conus vittatus Hwass, Encycl. Méth., Hist. Nat. Vers, Vol. 1, Genus *Conus*, p. 704, 1792; Reeve, Conch. Icon., Vol. 1, *Conus*, sp. 75, pl. 14, figs. 75*a*, 75*b*, 1843; Kiener, Spéc. Gén. et Icon. Coq., Vol. 2, *Conus*, pl. 63, fig. 5, 1845-46; p. 110, 1847; Dall, Proc. U. S. Nat. Mus., Vol. 38, p. 221, 1910; Nautilus, Vol. 32, p. 23, 1918.
? *Conus henoquei* Bernhardi, Journ. Conchyl., Vol. 8, p. 380, pl. 13, fig. 4, 1860, *fide* Dall, 1910.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918).
Recent: Acapulco, Mexico, to Panama.

We have not seen authentic specimens of this species.

Family TURRIDAE

(+ PLEUROTOMIDAE; also TURRITIDAE)

Shells of various shapes and sizes, usually distinguished by a posterior notch, slit, or sinus near the top of the outer lip. The typical genera are of medium size, fusiform in general shape, turreted or round-whorled, operculate; but many of the other common genera have high conical spires and short anterior canals, and some of the deep-water forms are small, thin-shelled, inoperculate.

Geologic range: Cretaceous to Recent.

Important references for the family are as follows:

Kiener, Spéc. Gén. et Icon. des Coq. Viv., Vol. 5, *Pleurotome*, 81 pp., 27 pls., Paris, 1839-40.
Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, 40 pls. with descriptions, 1843-46; Vol. 3, *Mangelia*, 8 pls. with descriptions, 1846.
Bellardi, "Mon. Pleur.," R. Accad. delle Scienze di Torino, Memorie, Ser. 2, Vol. 9, pp. 531-650, pls. 1-4, (1847) 1848.
H. and A. Adams, Gen. Rec. Moll., Vol. 1, pp. 87-100 (Vol. 2, p. 614) ill., London, 1853.
Bellardi, "Prodromus," Bollettino della Società Malacologica Italiana (Pisa), Vol. 1, pp. 16-24, 1875.
Weinkauff, Deutsche Malakozoologische Gesellschaft (Frankfurt-am-Main), Jahrbuch, Vol. 3, 1876; Vol. 4, 1877.
Bellardi, Moll. Tert. do Piemonte, Pt. 2, R. Accad. della Scienze di Torino, Memorie, Ser. 2, Vol. 29, pp. 1-324, pls. 1-9, (1877) 1878.
Tryon, Struct. and Syst. Conch. (Vol. 1, p. 50), Vol. 2, pp. 183-186, Philadelphia, 1883.
Fischer, Man. Conchyl., pp. 589-594, ill., Paris, 1883.
Tryon, Man. Conch., Vol. 6, pp. 151-413, 34 pls., Philadelphia, 1884.
Monterosato, Nomen. Gen. Spec. Conch. Medit., pp. 126-137, Palermo, 1884.
Weinkauff (and Kobelt), Syst. Conchyl. Cab., N. S., Vol. 4, Pt. 3, 248 pp., 43 pls., Nürnberg, (1875—) 1887.
Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 18, pp. 71-128, ill., 1889.
Boettger, Deutsche Malakozoologische Gesellschaft (Frankfurt-am-Main), Nachrichtsblatt, 1895.
Cossmann, Ess. de Paléo. Comp., Vol. 2, pp. 56-148, ill., 1896.
Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, pp. 37-65, ill., London, 1897.
Casey, Trans. Acad. Sci., St. Louis, Vol. 14, no. 5, pp. 123-170, 1904.
Cossmann, Ess. de Paléo. Comp., Vol. 7, pp. 218-224, ill., 1906.
Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, pp. 255-293, ill., 1908.
Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 313-333, 1918; Vol. 56, pp. 1-86, pls. 1-24, 1919.
Hedley, Rec. Australian Mus., Vol. 13, no. 6, pp. 213-359, pls. 42-56, 1922.
Thiele, Deutsche Tiefsee-Expedition, Wissenschaftliche Ergebnisse, Vol. 17, Pt. 2, Gastropoda, pp. 202-256, ill., 1925, includes descriptions of radulæ.
Woodring, Carnegie Inst. Wash., Publ. No. 385, pp. 144-201, 1928.

Nearly everyone who has had occasion to write about the *Turridæ* has mentioned in one way or another the unsatisfactory state of the classification, the chaotic condition of the nomenclature with its vast store of superfluous names, and the great difficulty of grouping the shells in a natural order. The writers have found it impossible at the present time to do more toward straightening out the confusion that prevails in this family than to point out some of the more evident changes in nomenclature required by the application of the modern rules, and to suggest a makeshift classification based mainly upon observable shell characters so that the species here noted will find at least a temporary resting place. It is hoped that this classification will be more logical, more natural, more nearly in accord with the phylogenetic relationships than those hitherto proposed; but it is clear that a great deal more study and more detailed observation on large series of fossil and living shells in all stages of growth, and on living animals, will be necessary before a thoroughly satisfactory arrangement can be expected.

Fischer's classification, which has been followed with various modifications by many of the later workers, is based primarily on the form of the operculum. The operculum may have a terminal nucleus as in *Turris*, or a nucleus situated near the center of the left side as in *Clavatula*, or a paucispiral, subcentral nucleus as in *Steiraxis*, or it may be entirely lacking as in *Mangelia*. Although it is perfectly reasonable to take account of the nature of the operculum (where possible) as one of the characters of a species or genus, like its size, shape, or ornamentation, it seems not unlikely that the disproportionate emphasis placed on this single character is responsible for part of the difficulty experienced in dealing with the family. In other families it is recognized that related genera, that related species in the same genus, that even individuals in the same species may differ as to the shape or as to the presence or absence of their opercula, and that sometimes if an individual lose its operculum it may grow one of a different shape in its place. Thiele relies principally on the radulæ for his classification, paying some attention to the opercula, but apparently regarding the shell characters as of very subordinate importance. He would separate the operculate members of the family, with the exception of the forms formerly called *Bela*, here referred to *Lora*, into a new superfamily, Pseudotoxoglossa, because these forms have in their radulæ a continuous membrane into which the teeth are set in regular rows as in other normal gastropods. Although Thiele's contribution of descriptions and illustrations of previously unknown radulæ is surely of considerable importance, it is hard to jusify his faith in the supreme value of one part for classification. It is true that radulæ have been used as the basis for separating other large groups of gastropods; but the classification of gastropods is still only tentative, and it may not be amiss to wonder whether the widespread faith in the value of the most inaccessible parts of the animal is not entirely due to the comparatively limited knowledge of them. Other characters which are apparently distinct when studied in isolated individuals have been found in large series to pass through insensible gradations from one extreme to another, and it is hardly to be expected that comparable variability will not be found in all characters, that now one and now another will be a more reliable clew to phylogeny.

In the case of the *Turridæ* the presumption is against the value of opercula and radulæ for classification, for they point to nothing with the ear-marks of order, tending merely to confuse by separating into widely different groups genera which are shown by their other characters to form links in a normal intergrading series; and they are sometimes contradictory, as in the case of anomalous forms like the genus *Lora*, which the radula would classify with the inoperculate group and the operculum would classify with the "Pseudotoxoglossa." It is not at all certain that the different radulæ and opercula are not the result of generic or even specific adaptation to environment, and that the latter may not be a secondary feature dependent upon the shape of the shell aperture. The larger sized genera like *Turricula*, *Clavatula*, *Clavus* and *Surculites* are represented by very similar forms in the Cretaceous, whereas representatives of the smaller, thinner genera are not known until later, either because they were less suited for preservation or because they evolved later. It would be natural for the larger forms when adapting themselves to colder or deeper waters or other specialized conditions to develop smaller, thinner shells and at the same time to lose the need of opercula and of stiffening membranes in the radula. The evolution might affect different parts at different rates in different lines of descent so that *Lora* lost its membrane before its operculum and *Genota* lost its operculum before its membrane, and *Leucosyrinx* retained both and just grew thin. If such is the case, some of the branches of the small inoperculate group may be more closely related to the particular branches of the large operculate group from which they were derived than they are to each other, and they should not be separated as a different family, subfamily, or superfamily.

At other times, the protoconchs or embryonic whorls have been appealed to as a basis for classification, some writers going so far as to bring together very unlike species because they have similar protoconchs and to separate otherwise similar species because their protoconchs differ. In regard to this matter also, it seems wise to take careful note of the protoconchs (where possible), but in most cases not to rely upon them when they contradict the evidence afforded by other characters. It is well to recognize that the significance of protoconchs is still very imperfectly understood, that the protoconchs of few species are accurately known, that even on living specimens the protoconchs are seldom preserved in the adult, that if preserved, erosion may entirely alter their aspect, and that in the *Buccinidæ* and other groups where the embryonic shells can be collected from the egg capsules of individual specimens it has been observed that several different kinds of protoconchs are present as offspring of the same parents. Sometimes the characters of the protoconchs may be due to an acceleration of the time of the development of the adult characters, in which case they would not necessarily indicate genetic relationships; and in some cases the form of the protoconch may be determined by the environment through natural selection, being perhaps as late in phylogenetic development as the adult characters. In other words, it is best to pin our faith not upon characters rarely observable and very imperfectly understood but upon characters the development of which can be seen and traced, upon specific relationships as shown by the intergrading or close approach of similar variations, taking into account all observable characters. In this connection, the following quotation from Dall is appropriate:

> "In common with most students of the mollusca for some years I have regarded the nucleus characters as more or less indicative of genetic affinity, but recently having had to work over large numbers of deep water species, especially toxoglossate forms, and to utilize Hedley's fine monograph of the Australian Turridæ, I have found this view to involve so many apparently preposterous combinations of unlike things and separation of similar things, that I have come to the conclusion that this view cannot be maintained."[1]

The accompanying diagram, in the form of a horizontal cross section of the Turrid family tree, shows what the writers believe to be in general the natural relations of the family. It is an attempt to represent graphically the interrelations between the various genera that are described in the text so that the arrangement may be better visualized. Each genus is enclosed by a line, and when adjacent genera intergrade and are difficult to distinguish, the lines overlap. These intergradations are not in simple series but in complicated irregular patterns, the overlapping sometimes occurring in many directions, sometimes in directions that are hard to explain. It has been possible to show in this fashion nearly all of the intergradations that the writers have recognized, though too much cannot be expected of a two-dimension diagram of such a subject as this, which if all the facts were known would require a many-dimension diagram to represent it adequately.

Many vertical sections would be necessary to show the genetic series; and there is not enough information at hand to make it worth while to try to draw them now. The development of the groups indicated must be imagined somewhat as the hanging branches of a vine, each one with forks and side branches and numerous radiating fronds; and if such a vine were lowered into a still pool of water the various branches would cause circular ripples somewhat like the lines drawn in the diagram. As explained below, the form most like the ancient radicle from which the vine grew is probably the subgenus *Knefastia* of *Clavatula, sensu lato*. The main *Clavus* branch is fairly distinct. The *Borsonia, Turris, Leucosyrinx*, and *Surculites* branches all have something in common with the ancient *Turricula* stock, and probably developed either through *Turricula* or parallel to it.

Several other families show evidence that they are more or less closely related to the *Turridæ*. The *Conidæ*, for instance, have a toxoglossate radula, a small horny operculum which is sometimes present, sometimes absent, and often a posterior sinus at the top of the body whorl. They are however, easily distinguishable by their low spire and conical shape and by their habit of partially resorbing the interior walls of the spire whorls. The *Terebridæ* have a toxoglossate radula, an anal fasciole or slit band, though no posterior sinus, and are resembled by *Pusionella* and *Melatoma*. They are distinguished by their high, many-whorled conical spire, and short, twisted columella. The radulæ of these two families are apparently more extreme than those of the *Turridæ*, for in the *Turridæ* not

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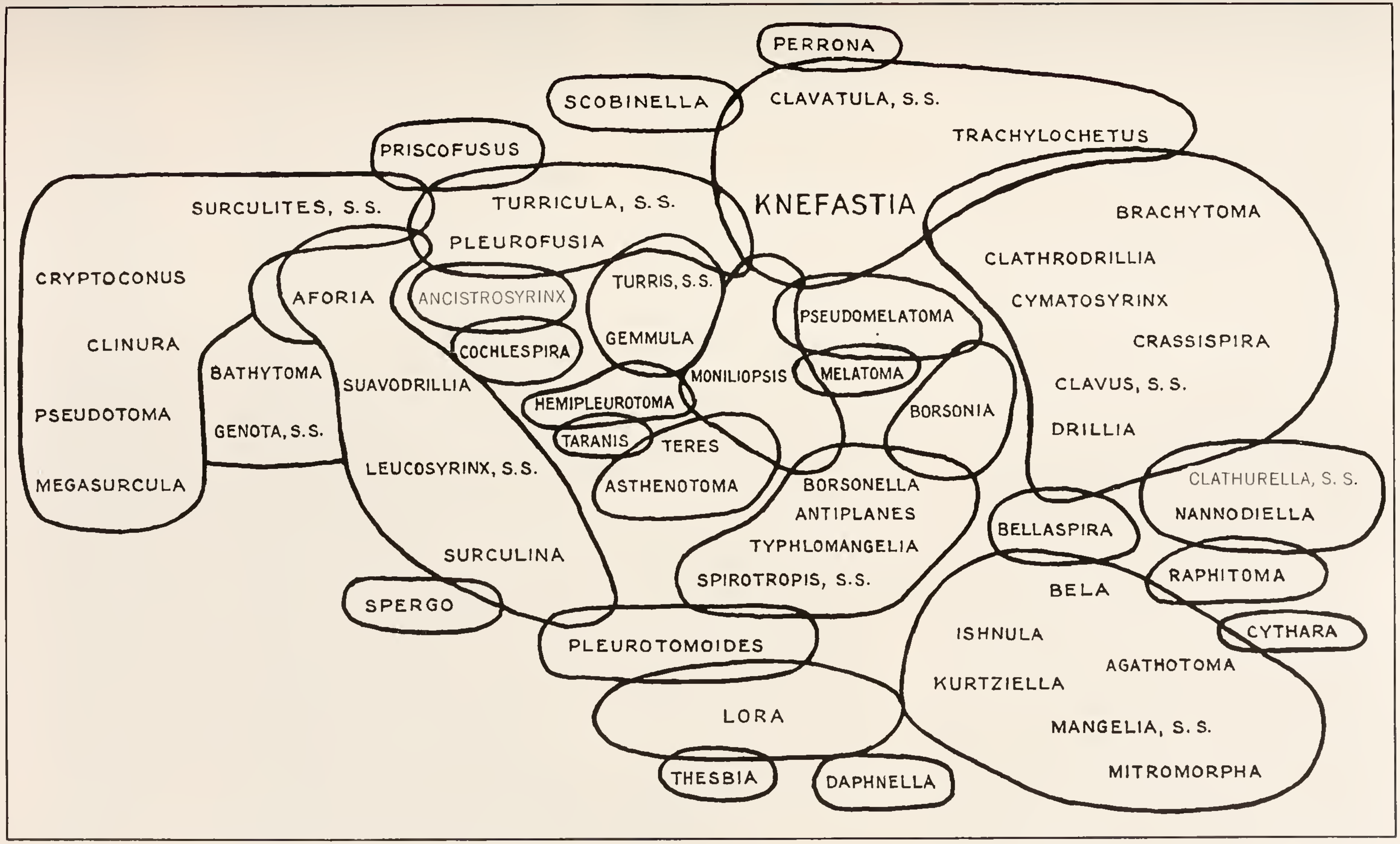
[1] Journ. Wash. Acad. Sci., Vol. 14, p. 178, 1924.

DIAGRAM D


PERRONA
SCOBINELLA
CLAVATULA, S. S.
TRACHYLOCHETUS
PRISCOFUSUS
SURCULITES, S. S.
TURRICULA, S. S.
KNEFASTIA
BRACHYTOMA
PLEUROFUSIA
CLATHRODRILLIA
CRYPTOCONUS
AFORIA
ANCISTROSYRINX
TURRIS, S. S.
CYMATOSYRINX
PSEUDOMELATOMA
CLINURA
GEMMULA
CRASSISPIRA
COCHLESPIRA
BATHYTOMA
SUAVODRILLIA
MONILIOPSIS
MELATOMA
CLAVUS, S. S.
HEMIPLEUROTOMA
BORSONIA
PSEUDOTOMA
GENOTA, S. S.
DRILLIA
TARANIS
TERES
LEUCOSYRINX, S. S.
CLATHURELLA, S. S.
MEGASURCULA
ASTHENOTOMA
BORSONELLA
ANTIPLANES
NANNODIELLA
BELLASPIRA
TYPHLOMANGELIA
SURCULINA
RAPHITOMA
SPIROTROPIS, S. S.
BELA
SPERGO
CYTHARA
ISHNULA
PLEUROTOMOIDES
AGATHOTOMA
KURTZIELLA
LORA
MANGELIA, S. S.
MITROMORPHA
THESBIA
DAPHNELLA

HORIZONTAL CROSS-SECTION OF THE TURRID FAMILY TREE all of the forms have yet become toxoglossate. The *Pyrenidæ* have a rachiglossate radula, like that of the "Pseudotoxoglossa" branch of the *Turridæ*, and often resemble the *Conidæ* or the *Turridæ* in shape. The posterior flare or canal at the top of the outer lip which is often so conspicuous in the *Pyrenidæ* has probably the same function as the sinus that characterizes the other two families. Some species and varieties of the smaller genera, like *Anachis* and *Cythara* or *Mangelia*, *Amphissa* and *Lora*, in which the flare or sinus may be obscure, are often very difficult to distinguish. The similarity may be due entirely to parallel adaptation to similar environments, but it seems probable that the families are more closely related than is generally admitted. The rachiglossate *Volutidæ* are related through the Cretaceous *Drilluta* Wade, and the *Mitridæ* through the Tertiary *Scobinella* Conrad and possibly through the Tertiary to Recent *Mitromorpha*. Some of the fossils are very difficult to distinguish. Lastly, the more ornate species of *Turricula*, *Clavatula*, and *Clathrodrillia* often resemble *Fasciolariidæ*, *Neptuneidæ*, etc. In nearly all cases the *Turridæ* can be distinguished from the members of other families by the posterior sinus; and even in specimens where the aperture is defective, the sinus is usually recognizable as an incurving of the growth lines.

Genus **CLAVATULA** Lamarck, 1801

Clavatula Lamarck, Syst. Anim. s. Vert., p. 84, 1801; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 65, 1896; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 315, 1918; Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, pp. 204, 205, 207, 1925.

Not "*Clavatula* Lamarck," Swainson, Treat. Malac., pp. 155, 314, 1840, sole species *C. sulcata* Swainson, Chemnitz fig. 1829 = *Pleurotoma flavidula* Lamarck, a *Clavus* (*Clathrodrillia*).

Type (by monotypy), *Clavatula coronata* (Chemnitz) Lamarck, 1801 = *Murex* (*Turris*) *coronata* Chemnitz, Neues Syst. Conchyl. Cab., Vol. 11, p. 114, pl. 190, figs. 1831, 1832, 1795; not *Pleurotoma coronata* Lamarck, 1803, originally described as *Fusus*. Type living on the coast of Guinea, West Africa. A specimen similar to that figured by Chemnitz is shown on plate 25, figures 16*a*, 16*b*.

Shell relatively large, of medium weight, generally with a high or moderately high spire, turriculated, with an anterior canal of variable length, typically short; sculptured below the angle with axial ribs and spiral cords, sometimes of approximately equal development and forming a network with small nodular points at the intersections, sometimes with coarse axial ribs forming elongate nodes on the shoulders of the whorls and crossed by rugose spirals weaker at the intersections; above the angle the area of the slit-band or anal fasciole unsculptured except for growth lines concave toward the aperture, and in typical species above the slit-band and immediately below the suture one or more additional nodular spirals, the upper nodes sometimes standing out like a collar or crown of thorns or spines; sutures high on the preceding whorl, channeled, coarsely or finely flexuous according to the sculpture of the preceding whorl; aperture ovate, outer lip simple except for the slight crenulations of the edge caused by the sculpture and the moderately deep, rounded posterior sinus situated above the shoulder but separated from the suture by the additional sculptured area just described, the additional sculptured area projecting outward and forming a narrow posterior canal; inner lip covered with a thin callus, without any pile of shelly material below the suture; columella straight or slightly flexed, often slightly umbilicate, typically short but more often somewhat produced and with a distinctly defined anterior canal which may be very slightly enlarged and twisted at the extremity; operculum horny, with the nucleus near the middle of the columellar side.

Geologic range: Cretaceous to Recent.

Distribution: Tropical and subtropical waters of all oceans.

The genus *Clavatula* is considered here ahead of *Turris*, the type genus of the family, because it is one of the genera that appeared early in the fossil record and is probably the closest representative of the archetype from which the family was derived. The name

Clavatula is one of the oldest in the family, being second only to *Turris* with its synonym *Pleurotoma;* and as it applies to a group of forms which are considered generically distinct from *Turris*, it must be clearly defined before the status of many of the later names can be determined.

The name *Clavatula* has been misused, neglected, or applied very indefinitely to a group of forms which most writers have considered foreign to their territory. *Clavatula imperialis* Lamarck has long been cited erroneously as the type; and although that species is probably congeneric with *Clavatula coronata*, it is of such a peculiar form that related species have not been easily recognized. Many of the species formerly called *Surcula* and *Turricula* should be included. *Clavatula coronata* appears to be very variable in character, including within its range of variation forms which some writers would be inclined to separate into different genera. Chemnitz described one of the varieties in an earlier volume of the "Conchylien Cabinet" (Vol. 4, p. 176, figured on Vignette 39, fig. C, p. 143, 1780) as *Turris babylonica coronata*, and this variety has since been recognized as *Clavatula muricata* Lamarck. It is distinguished from the typical variety of *coronata* which Lamarck cited in describing *Clavatula* by its stumpy spire, relatively longer columella, and its more prominent spines.[1] The variety *bimarginata* Lamarck, which is considered conspecific with *coronata* by Deshayes and Tryon, is distinguished by its larger size, its longer columella, and its less developed spines.[2] The various figures of these varieties and the figures given by Tryon of additional varieties from approximately the same localities serve to bridge completely the supposed gaps between the extreme forms.

The genus *Clavatula* as illustrated by its type species is a generalized form. The notch and sculpture are irregular and variable, intermediate in character between the corresponding features shown by the various main divisions of the family. Hence it is that *Clavatula* is suspected of being the ancestor of the family. *Perrona* has been derived from a form of *Clavatula* with the suture high on the preceding whorl by a reduction of the notch and the loss of nearly all the sculpture; *Melatoma, Moniliopsis, Pseudomelatoma, Borsonia*, and *Spirotropis* have been derived from a similar form by a heightening of the spire, a shortening of the columella, a reduction of the notch, and the loss of sculpture; *Turris, Hemipleurotoma, Cochlespira, Genota, Turricula, Aforia, Ancistrosyrinx, Surculites, Pleurotomoides, Lora*, etc., have been derived in a similar way through a modification of the notch and of the general shape and by a simplification of the sculpture in successive stages as described below; *Clavus, Cythara, Mangelia, Clathurella, Raphitoma*, etc., have been derived by an armoring of the outer lip and notch and at the same time a reduction in size, a modification of the sculpture and a shortening of the canal, also in successive stages; and *Scobinella* has been derived by the development of strong folds on the columella. Thus practically all the members of the family can be traced directly or indirectly from a *Clavatula*-like ancestor, and the family unity is explained. It is to be expected, of course, that further study along these lines will show that the relations are much more complex than they are here described, but the writers believe that a beginning is made toward an understanding of the group, and that most of the genetic series are outlined approximately correctly. Since the various forms of *Clavatula* grade without any essential break into forms representative of the main branches of the family, it is necessary to split off the first members of the several series arbitrarily, and there is of course room for differences of opinion about where the limits should be set. Cretaceous species of *Turridæ*, at least some of which appear to be congeneric with the type of *Clavatula*, though perhaps more closely related to the subgenus *Knefastia*, are described and illustrated by Wade.[1]

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[1] *C. coronata* var. *muricata* (Lamarck) is figured by Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 24, pl. 17, figs. 2, 2*a*, 1839-40; by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 5, species 31, 1843; and by Tryon, Man. Conch., Vol. 6, p. 229, pl. 8, fig. 22, 1884.

[2] *C. coronata* var. *bimarginata* (Lamarck)—see Deshayes in Lamarck, Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 9, p. 360, 1843, note on *Pleurotoma taxus* Kiener. This variety figured by Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 29, pl. 2, figs. 2, 1839-40; by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 5, species 34, 1843; and by Tryon, Man. Conch., Vol. 6, p. 229, pl. 8, fig. 15, 1884.

Subgenus **CLAVATULA**, s. s.

Suture mounting high on the preceding whorl, prominently sculptured with nodules or spines, the anal fasciole lying in a deeply concave area below this upper sculptured band.

Geologic range: Miocene and Pliocene of Europe (*fide* Cossmann).

Distribution: West Coast of Africa.

The subgenus which has, through the chances of nomenclatorial history, become typical is leaning strongly toward *Perrona*. It includes the type species and its varieties, also *Clavatula imperialis* Lamarck, though the latter is a somewhat odd form, and others reviewed and illustrated by Tryon. The type and its variety *bimarginata* are illustrated herewith for comparison (plate 25, figures 16*a*, 16*b*, and 14*a*, 14*b*, respectively).

Subgenus **KNEFASTIA** Dall, 1919

Knefastia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 3, 1919; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 167, 1928.

Type (by original designation), "*Pleurotoma olivacea* Sowerby, 1833, not of Reeve, 1843, + *funiculata* Valenciennes, 1839."

Shell large, with coarse axial and spiral sculpture, biconical, canal of moderate length, notch moderate, rounded, somewhat distant from the suture, not armored; suture not so high on the preceding whorl as in typical *Clavatula*, and the sculpture above the slit-band not so prominent.

Geologic range: Cretaceous to Recent; Miocene of the West Indies (*fide* Woodring).

Distribution: Gulf of California to Ecuador.

These forms are very much like *C. coronata* var. *bimarginata* (Lamarck) in character, except that the suture is not so high on the preceding whorl and the sculpture between the anal fasciole and the suture is confined to an inconspicuous narrow band. These species are evidently leaning toward *Turricula*, but the strength of the axial sculpture, the general shape, and the position of the notch relate them more closely with *Clavatula*. *Clavatula olivacea* and *C. tuberculifera* (Broderip and Sowerby) are very similar in generic characters to *C. ripleyana* (Conrad) from the eastern Cretaceous. *Clavatula* (*Knefastia*) *resina* (Dall),[2] a species living in the Gulf of Panama, apparently belongs to this group; but *T. nigricans* Dall, referred by its author to *Knefastia*, is probably a *Turricula*.

Clavatula (Knefastia) olivacea (Sowerby)

Plate 25, Figures 15*a*, 15*b*

Pleurotoma olivacea Sowerby, Proc. Zool. Soc. London, p. 136, 1833; Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 4, species 27, 1843; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 208, 271, 330, 1857.

Pleurotoma funiculata Valenciennes in Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 24, pl. 16, figs. 1, 1839; Reeve, Conch. Icon., Vol. 1; *Pleurotoma*, pl. 11, fig. 95, 1843; Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 390, 1857; Brit. Assn. Adv. Sci., Rept. for 1856, pp. 226, 238, 258, 282, 294, 1857; Rept. for 1863, pp. 538, 541, 623, 1864.

Surcula olivacea Sowerby, Tryon, Man. Conch., Vol. 6, p. 237, pl. 5, figs. 69, 70, pl. 34, fig. 3, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 207, 1909.

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[1] Wade, Bruce, "The Fauna of the Ripley Formation on Coon Creek, Tennessee," Prof. Paper 137 U. S. Geol. Survey, pp. 110-113, pls. 25-27, in part, 1926.

[2] *Turris* (*Surcula*) *resina* Dall, Bull. Mus. Comp. Zool., Vol. 43, p. 264, 1908.

? *Clathrodrillia resina* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 16, pl. 2, fig. 4, 1919.

Shell large, biconic, spire moderately high, whorls shouldered, with about ten coarse, rounded, axial ribs which project from the shoulder like nodes, crossed by coarse spiral riblets and striæ, area of the anal fasciole above the shoulder smooth except for lines of growth, concave, separated from the suture by an inconspicuous band, the strength of the shoulder varying with the slope and width of the anal fasciole; aperture oval, elongate, including the canal about half the length of the shell, outer lip made irregular by the sculpture, posterior notch deep, rounded, midway between the angle and the suture, columella of medium length, straight, sometimes umbilicate, inner lip inconspicuous, anterior canal indistinctly defined, about three-fifths as long and as wide as the aperture, slightly flaring at the end; operculum "formed like an obtuse-angled triangle, with the base along the columella, nucleus near the canal, the other angles rounded."

Dimensions (of figured specimen): Altitude, 50 mm.; length of aperture (including canal), 26 mm.; maximum diameter, 21 mm.

Type specimen: In the British Museum ?

Type locality: West Colombia.

Pleistocene: Coast of Oaxaca, Mexico, collected by R. H. Palmer.
Living: West coast of Mexico to Ecuador.

Reeve's figure of *olivacea* is more round shouldered than *funiculata* (Valenciennes in Kiener), which equals, according to Dall, *olivacea* (Sowerby); but it does not seem as if the two should be separated. Some specimens are more round shouldered than others. This species may be but a variety of the next.

Clavatula (Knefastia) tuberculifera (Broderip and Sowerby)

Plate 25, Figures 10*a*, 10*b*

Pleurotoma tuberculifera Broderip and Sowerby, Zool. Journ., Vol. 4, p. 378, 1829; Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 8, species 63, 1843.
Surcula tuberculifera Broderip and Sowerby, Tryon, Man. Conch., Vol. 6, p. 238, pl. 5, fig. 68, pl. 10, fig. 60, 1884.

Shell like that of *olivacea*, but with narrower tabulation, more rounded shoulder, and higher spire.

Dimensions (of figured specimen): Altitude, 61 mm.; length of aperture (including canal), 27 mm.; maximum diameter, 20 mm.

Living: In the Gulf of California.

Section Carinodrillia Dall, 1919

Carinodrillia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 17, 1919.

Type (by original designation), *Clathrodrillia* (*Carinodrillia*) *halis* Dall, described *loc. cit.* and figured pl. 5, fig. 4, living La Paz, Lower California.

Like the section *Knefastia*, *s. s.*, but smaller, with a higher spire and shorter aperture, the sculptural band between the anal fasciole and the suture inconspicuous.

All the species assigned by Dall to the section *Carinodrillia*, except the one he designated as type, belong to a strongly carinated group in the subgenus *Clathrodrillia* of *Clavus*. The species *halis*, however, has a *Clavatula* notch and is apparently related to *olivacea*, resembling very closely young specimens of the latter.

Subgenus **TRACHYLOCHETUS** Cossmann, 1889

Trachylochetus Cossmann, Ann. Soc. Roy. Malac. Belgique, Vol. 24 (Ser. 4, Vol. 4), p. 250, 1889; Ess. Paléo. Comp., Vol. 2, p. 67, 1896.

Type (by original designation), *Pleurotoma desmia* Edwards, Eoc. Moll., p. 240, pl. 27, fig. 5, 1856, also figured by Cossmann, Ess., Vol. 2, p. 67, pl. 4, figs. 17-18, 1896, Eocene of the Anglo-Franco-Belgian Basin.

Shell like that of the typical subgenus but with less conspicuous subsutural band; smaller and with finer sculpture than that of the subgenus *Knefastia.*

Geologic range: Eocene to Miocene of Europe (Cossmann).

Living distribution: La Paz, Lower California.

Cossmann recognized *Trachylochetus* as a subgenus of *Clavatula* in 1896. The peculiar record of its range and distribution is probably due to the fact that most workers are not familiar enough with the form to recognize it. *Clavatula* (*Trachylochetus*) *andromeda* (Dall)[1] is very similar to *C. desmia.*

Genus **TURRICULA** Schumacher, 1817

Not *Turricula* Klein, pre-Linnæan.

Not *Turricula* Hermann, Tab. aff. Anim., Ed. 2, tabula G, 1783, cited in Sherborn's Index Anim., p. 1007, 1902, but not nomenclatorially available, see Iredale, Proc. Malac. Soc. London, Vol. 11, p. 294, 1915.

Turricula Schumacher, Ess. d'un Nouv. Syst., p. 217, 1817; Iredale, Proc. Malac. Soc. London, Vol. 12, p. 324, 1917; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 315, 1918; Hedley, Records Australian Mus., Vol. 13, p. 253, 1922; Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, pp. 205, 207, 1925.

Surcula H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 88, 1853, new name for *Turricula* Schumacher, not Klein, and 31 species cited, including *javanus* Linnæus; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 69, 1896, type cited *Murex javanus* Linnæus.

Surgula Weinkauff, Martini-Chemnitz Syst. Conch. Cab., Ed. 2, Vol. 4, pt. 3, 1875 (*fide* Dall), probably merely a transliteration.

Type (by monotypy), *Turricula flammea* Schumacher based on "*Murex javanus* Linnæus" Chemnitz, Neues Syst. Conchyl. Cab., Vol. 4, p. 172, pl. 143, figs. 1336-1338, 1870 + *Turris javanus* Bolten + *Murex tornatus* Dillwyn, 1817, not *Turris tornatum* Bolten, 1798, a true *Turris,* + *Pleurotoma* "*javana* Linnæus," Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 4, sp. 26, 1843, + *Surcula tornata* Dillwyn, Tryon, Man. Conch., Vol. 6, p. 237, pl. 5, fig. 62, 1884, etc.; figured herewith, plate 25, figs. 9*a*, 9*b*.

Shell large, of moderate thickness, with a high spire and typically a long anterior canal which is clearly differentiated from the aperture; whorls usually shouldered above the middle, concave above the shoulder, convex below, sculptured by spiral lines (which are obsolete on the type except on the lower part of the body whorl), and sometimes by nodes on the shoulder or short ribs extending obliquely downward; aperture wide, ovate, about half again as long as the anterior canal, the canal and aperture together being usually about half as long as the whole shell; outer lip thin, rounding in abruptly to form the edge of the anterior canal and curving backwards posteriorly into the deep rounded notch which lies in the nearly smooth concave area between the shoulder and the suture, above the notch the lip curving outward again at the end of a narrow sutural band which recalls the sutural band of *Clavatula,* inner lip slightly resorbed, columella flexuous, elongated, anterior canal parallel-sided, not wide, slightly notched behind; operculum with a nucleus on one side like that of *Clavatula.*

Geologic range: Cretaceous to Recent (*fide* Cossmann).

Distribution: Tropical seas, especially of the Pacific.

The nomenclature of this genus seems to be on the point of settling down. The name *Surcula* was proposed unnecessarily according to the modern rules of nomenclature for *Turricula* Schumacher believed to be preoccupied by the pre-Linnæan Klein. According to the writers' interpretation of the rules, Schumacher's species, *T. flammea,* and the 31 species listed by the Adams brothers are all available for the type of *Surcula,* inasmuch as *Surcula* was not proposed definitely as a new name for *Turricula* Schumacher alone but for *Turricula* Schumacher and the 31 species. The type of *Surcula* has been cited several times as *Murex javanus* Linnæus, not "*Murex javanus* Linnæus" Chemnitz, Reeve, etc., and as this species is in the original list it should be considered the type. *Surcula* is not, however, sufficiently distinct from *Turricula* to be of use, for it differs only in being more strongly, more normally sculptured. The true *Turricula javana* (Linnæus) is figured by Tryon (Man. Conch., Vol. 6, p. 237, pl. 5, figs. 63-65, 1884), and by Reeve as *Pleurotoma nodifera* Lamarck (Conch. Icon., Vol. 1, *Pleurotoma*, pl. 4, sp. 28, 1843).

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[1] *Clathrodrillia andromeda* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 16, pl. 2, fig. 2, 1919.

Turricula is related to *Clavatula*, not only by its operculum but also by its general shell characters. Thiele says that there are so many intermediate species that he doubts if the two genera can be distinguished. However, it seems advisable to make the separation, even if it is somewhat arbitrary, at the point where the anterior canal becomes long and narrow, the sutural band inconspicuous, and the sculpture simpler. Other points of difference can probably be worked out more or less satisfactorily, and although the intergradations are evident, the groups seem to be on the whole fairly natural units. It is even more difficult to separate *Turricula* from *Turris*, especially in the older formations, and Harris decided that it was not worth while to try. In most cases, however, the separation can be made on the basis of the shape and position of the notch, as well as by the operculum in living species. In *Turricula* the notch is above the angle and rounded; in *Turris* it is on the angle and is deep and square-ended or at least angular. *Turricula* grades into the early forms of *Spirotropis* through such species as *Turricula piercei* (Arnold), and the final basis of separation is the short canal of the latter. It also grades into and is the probable ancestor of *Aforia* and related groups which have a still longer anterior canal in relation to the rest of the shell. *Surculites* and *Genota* are probably related, but they do not have the anterior canal defined; in them the body whorl rounds down in a smooth, sometimes nearly straight curve to the base. *Priscofusus* and *Pleurofusia* are also related.

The type of *Turricula* is an almost smooth form, with faint striations only on the lower half of the body whorl, most of the sculpture having become obsolete. The true *Turricula javana* (Linnæus) has the same shape but retains a fairly strong spiral sculpture from the shoulder downward and also on the sutural band, with in addition a row of somewhat irregular small oblique nodes on the shoulder. These two species, which were confused by Chemnitz and others, should be separated only specifically. The same is true, of the species selected as genotypes of some of the new genera proposed by Casey[1] such as *Protosurcula* and *Orthosurcula*. Casey's work has been unfavorably but justly criticised by Cossmann,[2] who has concluded that these two names at least should not be separated from *Surcula* (= *Turricula*). *Turricula australis* (Lamarck), which Casey includes in "*Orthosurcula*," has a longer, straighter anterior canal and stronger, beaded spiral cords than *Turricula flammea;* but the differences are specific, no more. *Turricula kaderleyi* (Lischke) has faint spiral sculpture and strong, elongated, oblique nodes on the angle being similar in general form and sculpture to *T. ochsneri* (Anderson and Martin). The extreme variant from the type in the opposite direction from *T. australis* is *T. maculosa* (Sowerby), having a relatively short, poorly differentiated anterior canal, and sharp rounded nodes on the angle. This and related species might better deserve a sectional name than many of the artificially separated groups already named; but the intermediate species *T. catena* (Reeve) shows clearly the relationship, and it appears that nothing would be gained by introducing a new name. The writers believe that no new generic names should be proposed in the *Turridæ* until a beginning has been made toward an understanding of the relationships of the three hundred odd supposed generic groups already named, a thing which obviously no one yet has done.

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[1] Casey, Trans. Acad. Sci., St. Louis, Vol. 14, pp. 123-170, 1904.

[2] Cossmann, Ess. Paléo. Comp., Vol. 7, pp. 218-224, 1906.

Turricula piercei (Arnold)

Pleurotoma (*Bathytoma*) *piercei* Arnold, Bull. 396, U. S. Geol. Survey, p. 61, pl. 9, fig. 7, Jan. 15, 1910; figure reprinted in Bull. 398, pl. 31, fig. 7, 1910.

Bathytoma piercei Arnold, Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 179, 1912; Anderson and Martin, Vol. 4, p. 42, 1914.

Shell of small or moderate size for this genus, nearly smooth except for remnants of nodulations on the early whorls; notch, angulation of the whorls, etc., normal for the genus; columella only moderately long, somewhat flexuous, aperture and canal about half the length of the shell.

Middle Miocene: Monterey-Temblor stage, of the San Joaquin basin, California.

This species is similar to and probably intergrades with *Turricula ochsneri* (Anderson and Martin), but is distinguished by its obsolete sculpture. It is on the borderline between the genera *Turricula* and *Spirotropis,* and is here classed with the former because of its obvious relationship with *T. ochsneri* and because of its columella, which is longer than is usual for *Spirotropis.*

Turricula ochsneri (Anderson and Martin)

Drillia ochsneri Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 90, pl. 6, figs. 9*a*, 9*b*, 9*c*, 1914.

Drillia wilsoni Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 91, pl. 6, figs. 10*a*, 10*b*, 10*c*, 1914.

? *Surcula insulæ* Dall and Ochsner, Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 104, pl. 6, fig. 12, 1928.

Shell of moderate size, spire elevated, whorls angulated above the middle and surmounted by ten to eleven oblique axial ribs starting on the angle and dying out downward, crossed by faint spiral striations (usually eroded off), about four exposed on the spire whorls and twenty to twenty-two on the body whorl; aperture and canal together about half as long as the entire shell, but varying in length, posterior notch above the angle, deep, rounded, leaving behind it the concave fasciolar area and accounting for the angulation, columella slightly flexuous.

Dimensions (of type of *wilsoni* from Anderson and Martin): Altitude with defective apex, 47 mm.; diameter of the last whorl, 18 mm.; length of the aperture including the canal, 23 mm.

Type specimens: All at the California Academy of Sciences.

Type localities: Of *ochsneri*, middle Miocene of Barkers Ranch, Kern County, California; of *wilsoni*, middle Miocene of eastern San Luis Obispo County, California; of *insulæ*, probable Pliocene on east shore of Indefatigable Island, Galapagos Group.

Miocene: Type localities of *ochsneri* and *wilsoni*, middle Miocene; Santa Margarita formation, upper Miocene, from well cores of the Fruitvale district northwest of Bakersfield, California, six specimens (H. R. G.).

? *Pliocene:* Type locality of *insulæ*.

Anderson and Martin separated *ochsneri* from *wilsoni* probably because the latter is relatively more elongate, though they did not say so. There appears to be no other difference, and this character is too variable to be of significance. The Pliocene form, *insulæ,* is slightly more elongate and smaller, and may be varietally or even specifically distinct. It is not unlikely that the species as a whole is merely a variety of *T. piercei* (Arnold) in which the ribs did not become obsolete so soon. This species bears some similarity to *T. maura* (Sowerby), which is living at Guayaquil, Ecuador. It is more like a typical *Turricula* than is *T. maculosa* (Sowerby).

Turricula maculosa (Sowerby)

Plate 25, Figures 11*a*, 11*b*

Pleurotoma maculosa Sowerby, Proc. Zool. Soc. London, p. 135, 1833; Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 6, species 45, 1843.

Surcula maculosa Sowerby, Tryon, Man. Conch., Vol. 6, p. 236, pl. 5, fig. 57, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 207, 1909; Nautilus, Vol. 32, p. 23, 1918.

Turricula burragei Bartsch, Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 149, 151, 1924.

Shell rather small for the genus, high spired, whorls strongly angulated, the angulation coming at about the middle of the spire whorls, whorls concave above, only very slightly convex below, sloping inward, smooth except for very faint spiral grooves and on the angle small sharp nodes about ten to a whorl; aperture and canal together only about two-fifths as long as the shell, narrow, almost parallel-sided, outer lip thin, almost straight, the posterior notch above the angle, deep, rounded, inner lip slightly resorbed, columella stout, almost straight, anterior canal poorly defined, about two-thirds as long as the aperture.

Dimensions: Altitude, 34 mm.; length of aperture and canal, 13.5 mm.; diameter of body whorl, 10 mm.

Type specimen: In the Museum Cuming.

Type locality: West Colombia, in sandy mud at a depth of sixteen fathoms.

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California (Jordan, 1924); Pleistocene of Magdalena Bay, Lower California (Dall, 1918); upper Quaternary of San Ignacio Lagoon, Lower California (Jordan, 1924).

Living: Gulf of California to Guayaquil, Ecuador (Dall, 1909).

This species resembles in general form *Clavus unimaculatus* (Sowerby), but is easily distinguishable by its unarmored posterior notch, its longer columella, and its unnotched anterior canal. As mentioned above, it is an extreme form of *Turricula*. Its passage to *Spirotropis* is evident, though it clearly belongs to this genus. The name *burragei* Bartch, used by Jordan, appears to be a manuscript name, for a prolonged search of the literature has failed to reveal a description. Jordan's specimens were identified by Dall. They are now in the collection at Stanford University, and clearly belong to *maculosa* (Sowerby).

Turricula libya Dall

Turricula libya Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 2, pl. 2, fig. 5, 1919.

Living: Off Cape San Lucas, Lower California.

This form appears to be a slightly shorter, more solid variety of *T. maculosa.*

Turricula nigricans Dall

Turricula (Knefastia) nigricans Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 3, pl. 2, fig. 6, 1919.

Living: Off Lower California.

This species is similar to *T. maculosa* but has narrower ribs, only about eight to the whorl, extending downward more persistently than the nodes of *maculosa.* The spiral sculpture is plainer, but this character is too variable to be of significance. It is possible that *nigricans* is another synonym or variety of *maculosa,* with which its relationship is evident. It is comparatively remotely related to *Knefastia.*

Subgenus **PLEUROFUSIA** de Gregorio, 1890

Pleurofusia de Gregorio, "Mon. Faune Éoc. Alabama," Annales de Géologie et de Paléontologie, Vol. 7, p. 33, Palermo, 1890; Casey, Trans. Acad. Sci. St. Louis, Vol. 14, p. 152, 1904; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 166, 1928.

Tropisurcula Casey, Trans. Acad. Sci. St. Louis, Vol. 14, p. 153, 1904; Cossmann, Ess. Paléo. Comp., Vol. 7, p. 222, 1906, type cited *Drillia caseyi* Aldrich, Eocene to Oligocene; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 166, 1928.

? *Fusiturricula* Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 165, 1928, type (by original designation) *Turris (Surcula) fusinella* Dall, living in the Gulf of Panama, described and figured in the Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 261, pl. 14, fig. 7, 1908.

Type (by original designation), *Pleurotoma (Pleurofusia) longirostropsis* de Gregorio from the Eocene of Alabama, described and figured by de Gregorio, *op. cit.*, p. 34, pl. 2, figs. 26, 27, 1890. This species is said to be similar to *Pleurotoma servata* Conrad, Journ. Acad. Nat. Sci., Phila., Ser. 2, Vol. 1, p. 115, pl. 11, fig. 18, 1848.

Shell elongate, fusiform, with a high spire and a long, straight anterior canal; whorls shouldered, and sculptured with axial nodes or riblets crossed by spiral lines; notch like that of typical *Turricula.*

Geologic range: Eocene of California and Washington, Eocene and Oligocene of southeastern United States, Miocene of the West Indies.

Distribution: West coast of Panama and Mexico.

This subgenus is very closely related to the typical subgenus, so closely indeed that Cossmann considered it a synonym. Its unusually high spire, the exaggerated length of the columella below the constriction of the body whorl, and the stronger sculpture serve to distinguish it as a variational extreme. Casey and Woodring separated their genera on the basis of different protoconchs; but as pointed out above, the writers do not believe this character alone to be a reliable basis for separating or classifying genera.

Turricula (*Pleurofusia*) *fresnoensis* (Arnold) from the upper Eocene of the Coalinga district, middle California, and its probable synonym *Turricula* (*Pleurofusia*) *cowlitzensis* (Weaver) from the same horizon in Washington apparently should be classed in this subgenus.[1] This group is the only one on the Pacific coast that might cast doubt on the present interpretation of the genus *Priscofusus.* The two groups are easily distinguished by the position and the character of the posterior notch, but this character is not shown in Conrad's figure of the type of *Priscofusus.* However, Conrad's type is said to have come from the Miocene where *Priscofusus* is common, and *Pleurofusia* has not been reported from the Miocene of the northwest. The *Pleurotoma servatoidea* Aldrich, mentioned by Casey as distinguished from *Pleurofusia* by its notch, probably belongs to *Priscofusus.*

Genus PRISCOFUSUS Conrad, 1865

Priscofusus Conrad, Amer. Journ. Conch., Vol. 1, p. 150, 1865, original list includes *Fusus corpulentus* Conrad, *F. geniculus* Conrad, and others; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 8, 1901, type designated *F. geniculus* Conrad; Dall, Prof. Paper 59 U. S. Geol. Survey, p. 39, 1909, in part, type cited *F. corpulentus* Conrad.

Type (by subsequent designation, Cossmann, 1901), *Fusus geniculus* Conrad, described and figured in the U. S. Expl. Exped. (Wilkes), Vol. 10, Geology, p. 728, Geology Atlas, pl. 20, fig. 3, 1849, and described by Dall, Prof. Paper 59 U. S. Geol. Survey, p. 40, 1909.

Shell fusiform, with a high spire and a long, somewhat curving, anterior canal, whorls angulated, sculptured by numerous strong revolving lines, and by low axial undulations, nodes, or ribs on the angle, growth lines bending back below the suture in a broad, shallow, rounded embayment with its maximum depth nearly out at the periphery.

Geologic range: (Eocene ?), Oligocene and Miocene of the Pacific coast of the United States.

This genus name has remained for a long time practically a *nomen dubium,* and the obscurity in which it was hidden was increased by Dall's erroneous citation of *Fusus corpulentus* as the type. *F. corpulentus* Conrad was described and figured in the same place as *F. geniculus* (pl. 20, fig. 4), and is now identified as *Agasoma* (*Bruclarkia*) sp., possibly the same as *Priscofusus nodiferus* Conrad also figured in the same place (pl. 20, figs. 12, an impression, and 12*a*) but not named until 1865, and possibly also the same as the much better known *Agasoma acuminatum* Anderson and Martin (Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 73, pl. 5, figs. 4*a*, 4*b*, 1914). Hence, if an earlier designation of type should be found making *corpulentus* the type, *Bruclarkia* would become a synonym and *Agasoma* a subgenus.

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[1] *Pleurotoma fresnoensis* Arnold, Bull. 396 U. S. Geol. Survey, p. 53, pl. 4, fig. 23, Jan. 15, 1910, figure reprinted in Bull. 398, pl. 26, fig. 23, 1910.

Surcula cowlitzensis Weaver, Geol. Surv. Wash., Bull. No. 15, p. 53, pl. 3, figs. 30, 36, pl. 11, fig. 86, 1912.

However, Cossmann's designation appears to be valid, and the species he cited is very different. According to the figures given by Dall, the total length is more than four times as great as the maximum diameter. The writers are not now able to identify this species, but it is fairly certain to what group it belongs. This group probably should include most of the following:

Priscofusus hecoxi (Arnold)

Fusus hecoxi Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 371, pl. 33, fig. 8, 1908.
Drillia chehalisensis Weaver, Bull. Wash. Geol. Survey, No. 15, p. 78, pl. 6, figs. 65, 66, pl. 14, fig. 125, 1912.
Drilia hecoxi (Arnold), *Drillia chehalisensis* (Arnold), Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 30, pl. 4, fig. 48, 1916.

Oligocene: Of California, Oregon, and Washington.

Arnold's type has a wider apical angle than Weaver's, but Weaver himself recognized the synonymy.

Priscofusus sanctæcrucis (Arnold)

Fusus sanctæcrucis Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 371, pl. 33, fig. 3, 1908.

Oligocene: Of California.

Priscofusus medialis (Conrad)

Cerithium mediale Conrad, U. S. Expl. Exped. (Wilkes), Vol. 10, Geology, p. 728, Geology Atlas, pl. 20, figs. 1, 1*a*, 1849.
Priscofusus medialis Conrad, Amer. Journ. Conch., Vol. 1, p. 150, 1865.
Fusus (*Priscofusus*) *medialis* Conrad, Dall, Prof. Paper 59 U. S. Geol. Survey, p. 41, 1909.

Miocene: Of Oregon.

Priscofusus cammani (Dall)

Turris cammani Dall, Prof. Paper 59 U. S. Geol. Survey, p. 25, pl. 4, figs. 12, 13, 14, 1909; ?? Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 238, 240, 258, 1916; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93, 1922.
? *Turris carlsoni* Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 89, pl. 5, figs. 2*a*, 2*b*, 1914.

Miocene: Of Oregon.

Martin's identifications of specimens from the upper Miocene and Pliocene of northern California appear very doubtful. Dall's specimens were very poor casts. They probably belong either with *carlsoni* or with *medialis*.

Priscofusus coosensis (Dall)

Turris coosensis Dall, Prof. Paper 59 U. S. Geol. Survey, p. 24, pl. 2, fig. 3, 1909.
Turris coli Dall, Prof. Paper 59 U. S. Geol. Survey, p. 26, pl. 4, fig. 2, 1909.

Upper Miocene: Of Oregon.

Priscofusus lincolnensis (Anderson and Martin)

Turris lincolnensis Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 88, pl. 6, fig. 8, 1914.
Not *Turris lincolnensis* Van Winkle, 1918, renamed "*Borsonella ?*" *nuncapatia* Hanna, 1924.

Miocene: Of Oregon.

From a study of this group of species it is evident that there is here a natural group, to which, so far as the writers could ascertain, no other appropriate name has been applied. It is fortunate then that Cossmann selected one of them for the type of *Priscofusus*. The type resembles no other species so much as *P. hecoxi* (Arnold), as figured by Weaver; and Conrad's description shows that it is even more like that species than the figure indicates, for Conrad says the angle is below the middle of the whorls, whereas he figured it above. Nevertheless, the riblets on *P. geniculus* are more elongate, and the two species are said to come from different horizons, so the best that can be done is to say that the two are related. It is a pity that Dall did not figure Conrad's types when he had them before him. It is now left to the paleontologists of the Northwest to identify these old species.

Priscofusus is characterized by its fusiform shape and by its broad, almost *Fusus*-like posterior sinuation, which takes the place of the posterior notch. It is certainly not a characteristic form of notch for the *Turridæ*, and it is somewhat doubtful whether the genus should be placed here or with the *Fasciolariidæ* as Dall had it. However, the tendency lately has been to class the species with the *Turridæ*, and this alternative is more probably correct. The group appears to be related on the one hand to the shallow-sinus species of *Surculites* and on the other to the fusiform species of *Turricula*. Its notch is like that of the older *Turridæ*, like that of *Turricula fasciolata* Wade[1] from the Tennessee Cretaceous.

Martin's identification of specimens as belonging to the same species as Dall's casts of *P. cammani* is the only record of this genus in the Pliocene, and this record is here strongly questioned.

Genus SURCULITES Conrad, 1865

Surculites Conrad, Amer. Journ. Conch., Vol. 1, p. 213, 1865; Whitfield, Mon. No. 18, U. S. Geol. Survey, p. 217, 1892; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 420, 1926.

Type (by monotypy), *Surcula* (*Surculites*) *annosa* Conrad, *loc. cit.*, and pl. 20, fig. 9, 1865, a better figure of the type specimen given by Whitfield, *loc. cit.*, and pl. 33, fig. 14, 1892.

Shell of medium to large size, of general biconic form, usually somewhat turreted; whorls angulated, above the angle a broad, nearly flat, often concave area, unsculptured except for growth lines, this area either sloping at a low angle directly toward the preceding whorl and then turning up abruptly and forming a sutural collar, or starting at a low angle and curving concavely upward toward the suture high on the preceding whorl, or starting fairly steeply and reaching the suture with scarcely any curvature, sometimes producing in the last case an almost smoothly conical spire, shoulder either smooth or surmounted by a row of nodes, sometimes sharp, occasionally the nodes extending downwards as short riblets, the whorl on and below the shoulder sculptured with spiral lines, usually fine, and if well developed showing primary, secondary, and tertiary series, growth lines sometimes as strong as the spiral sculpture; aperture varying from two-fifths to a half the length of the shell, the outer lip running upward from the base in a nearly straight line (apertural view) to the shoulder and then turning toward the suture with an acute, right, or obtuse angle according to the slope of the area already described, from the side view curving outward in a broad arc; posterior notch broad and shallow, rounded, extending across the area above the shoulder; inner lip slightly resorbed, columella nearly straight, sometimes slightly flexed, anterior canal short, usually broad and not well defined, with a shallow notch behind.

At first sight it might be said that this genus as here outlined includes a number of forms differing too widely to be held within the limits of a single genus. The typical subgenus, the extreme with very tabulate whorls, appears to be a branch that split off and died out in the early Tertiary. The subgenus *Cryptoconus*, the non-tabulate, comparatively deep-notched extreme, apparently did the same. The intermediate, more normal subgenus *Clinura* lived on through the Miocene, possibly into the lower Pliocene of Italy, and gave rise to *Megasurcula* in California, which is still living. The subgenus *Pseudotoma* in Europe is analogous to the American *Megasurcula*, and may have been derived from

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[1] *Turricula fasciolata* Wade, Prof. Paper 137 U. S. Geol. Survey, p. 112, pl. 36, figs. 3, 4, 1926.

Surculites direct (for it is very similar in form), or through the subgenus *Clinura*. *Pseudotoma* is said by Cossmann to be still living. The genus as a whole is probably a derivative from *Turricula*, splitting off in early Eocene or late Cretaceous time; and its various subgenera show such striking similarities to *Turricula* (*olim Surcula*) that most of them have been included at one time or another in that genus. They can be distinguished, however, by the broader posterior notch and the short anterior canal and by the fact that the outer lip is not curved in rapidly below the aperture to define the canal as in *Turricula*.

Although the extreme forms of the various subgenera appear very distinct, a study of the variations of the species in the different groups and of the intermediate species shows that the treatment most in accord with nature is to group them all together. For instance, *S.* (*Megasurcula*) *carpenterianus* variety *cooperi* really looks more like the type of *Pseudotoma* than it does like the typical variety of the same species, and it bears such a striking resemblance to *S. wynootcheensis* of the typical subgenus that it seems hardly correct to separate the two subgenerically. The passage between the Eocene Clinuras of California, represented by *S.* (*Clinura*) *io* (Gabb), to *Megasurcula* through *S. keepi* Arnold is so gradual that it is practically impossible to decide where to draw the line. The living *S.* (*Megasurcula*) *remondii* is so much like *S.* (*Cryptoconus*) *filosus*, the type of *Cryptoconus*, that it can be told only by the not very different depth of the notch; and *S. sinuatus* (Gabb) of the typical subgenus bridges the gap between the type and the tabulate varieties of *S. remondii* from the lower Pliocene. *Cryptoconus* and *Pseudotoma* confound themselves in intergrading parallel series of variations in the early Tertiary of Europe.

It is possible that *Mesochilotoma* Seeley[1] is a still older name for this genus; but as pointed out by Stoliczka, the description is too brief to identify. The chances are greater that it belongs to some other group.

Subgenus **SURCULITES**, s. s.

Shell with sharply angled, tabulate whorls, sloping upward from the shoulder at a low angle toward the preceding whorl and leaving a considerable part of the preceding whorl exposed below the shoulder, sutural collar developed to a variable extent, and in well-preserved specimens small nodes on the angle.

Geologic distribution: Eocene of New Jersey (Conrad; Whitfield), of California and Washington (Gabb), of England (Stewart); also Miocene of Washington.

The typical form of *Surculites* is represented on the Pacific coast by *S. wynootcheensis* (Weaver),[2] *S. sinuatus* (Gabb), and *S. matthewsonii* (Gabb).[3] *S. wynootcheensis* (Weaver) has whorls which are fully as tabulate as those of the type species, but they are more rounded below and the sutural collar is somewhat wider. *S. sinuatus* is practically identical in form with *S. annosus* except that the area above the shoulder rises upward in a smooth concave curve instead of being pinched in below a sutural collar. These two species between them represent the typical form completely. The latter has small nodes on the early whorls, the former retains its nodes almost throughout life.

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[1] *Mesochilotoma* Seeley, Ann. and Mag. Nat. Hist., Ser. 3, Vol. 7, p. 284, 1861, type (by monotypy), *M. striata* Seeley, briefly described, *loc. cit.*, but never figured, Cretaceous upper Greensand of Cambridge, England; Stoliczka, Mem. Geol. Survey India, Palæo. Indica, Vol. 5, p. 68, 1867 (spelled *Mesochilostoma*); Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 328, 1918.

[2] *Turris wynootcheensis* Weaver, Wash. Geol. Survey, Bull. 15, p. 70, pl. 11, figs. 87, 88, 89, 94, pl. 14, fig. 121, 1912; Univ. Wash. Publ. Geol., Vol. 1, p. 52, pl. 5, fig. 65, 1916.

[3] For illustration, discussion, and references on Gabb's two species see Stewart, Proc. Acad. Nat. Sci., Phila., Vol. 78, pp. 420–421, 1926. The best figures of *sinuatus* are given by Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 5, pl. 10, figs. 2*a*, 2*b*, 2*c*, 1915.

Subgenus CLINURA Bellardi, 1875

Clinura Bellardi, Boll. Società Malac. Ital., p. 20, 1875, original list includes two species, *Pleurotoma calliope* Brocchi and *Pleurotoma elegantissima* Forbes; Mem. R. Accad. di Scienze di Torino, Ser. 2, Vol. 29, p. 204, (1877) 1878, type cited *Pl. calliope* Brocchi; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 74, 1896.

Nekewis Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 421, 1926, type (by original designation) *Fasciolaria washingtoniana* Weaver, described and figured by Weaver in Bull. No. 15, Geol. Surv. Wash., p. 52, pl. 1, fig. 5, 1912; also figured by Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 5, p. 72, pl. 10, figs. 7*a*, 7*b*, 1915.

Type (by subsequent designation, Bellardi, 1878), *Murex* (*Pleurotoma*) *calliope* Brocchi, Miocene of Italy, figured by Bellardi, *op. cit.*, p. 205, pl. 7, fig. 1, 1878, and by Cossmann, Ess. Paléo. Comp., Vol. 2, pl. 5, fig. 19, 1896.

Shell short and broad; whorls turreted, the area above the angle broad and only slightly concave, sloping up steeply and meeting the preceding whorl almost at the angle, angle ornamented with crenulations or riblets, sometimes extending downwards; aperture and canal about half the length of the shell, outer lip running up from the base to the periphery nearly in a straight line and then turning at right angles toward the suture, posterior notch very wide and shallow, rounded, columella moderately flexuous, anterior canal short, not wide.

Geologic range: Eocene of California, Oregon, and Alabama; Miocene and lower Pliocene of Italy.

There are a number of almost perfectly preserved specimens of *Surculites* (*Clinura*) *washingtonianus* (Weaver) in the collection at Stanford University that show even better than the figures how close this species is to the Italian type of the subgenus. *Pseudotoma bonellii* (Bellardi) from Italy, *op. cit.*, p. 218, pl. 7, fig. 13, 1878, also figured by Cossmann, *op. cit.*, pl. 7, figs. 11, 12, 1896, is probably also a *Clinura*, and likewise *Surculites* (*Clinura*) *io* (Gabb) from California, see Stewart, *loc. cit.*, and pl. 30, fig. 11, 1926.

The writers believe that even though the members of a group of similar forms should occur in widely separated localities, the group should not be dismembered into local genera or subgenera unless they can be separated on the basis of significant objective characters. There seems to be no way of distinguishing *Clinura* and *Nekewis;* and Stewart, although he mentions the former, does not attempt to do so.

Clinura is closely related to *Turricula*, and might be considered a variational extreme in the opposite direction from *Pleurofusia*. It can, however, be distinguished generically by its shorter form and broad, shallow notch. It is even more closely related to *Surculites* proper, *Pseudotoma*, and *Megasurcula*, sharing with them the broad conical shape and wide shallow notch, so that it is here not separated from them generically. However, it may be distinguished by its narrower, better formed anterior canal and longer columella. It probably was derived from *Turricula*, perhaps indirectly, and later gave rise to, or is a branch of the stock that gave rise to, *Pseudotoma* and *Megasurcula*. The intergradations between it and the last named are evident in the California and Washington Tertiary.

Clinura and typical *Surculites* are both well represented in the Eocene of the Pacific coast, and can be distinguished most easily by the slope of the area above the angle. *Clinura* lived on into the Miocene, where it is represented by *keepi* (Arnold), but by this time it had changed over sufficiently so that it is better to include *keepi* and the related species *condonanus* (Anderson and Martin) in the subgenus *Megasurcula* along with the later California species.

Subgenus **MEGASURCULA** Casey, 1904

Megasurcula Casey, Trans. Acad. Sci., St. Louis, Vol. 14, p. 147, 1904, list consists of *Pleurotoma* (*Surcula*) *carpenteriana* Gabb and its variety *tryoniana* Gabb.

Type (here designated), *Pleurotoma* (*Surcula*) *carpenteriana* Gabb.

Like *Clinura* but with a more massive columella and a wider, less clearly differentiated anterior canal, less often turreted, sometimes almost round-whorled like *Cryptoconus*.

Geologic range: Miocene to Recent in California.

Distribution: Monterey, California, to Todos Santos Bay, Lower California.

This group is barely distinguishable from *Pseudotoma*, but it is so clearly a descendant of the Pacific coast Eocene Clinuras that it appears to be nearer the truth to keep it separate from *Pseudotoma* and place it next to *Clinura*.

Surculites (Megasurcula) remondii (Gabb)

Plate 25, Figures 5, 6, 7, 8*a*, 8*b*

"*? Metula*" *remondii* Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 3, pl. 1, fig. 5, 1866.

Metula remondii Gabb, Geol. Survey Calif., Palæo., Vol. 2, p. 72, 1868-9; ? Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 176, 1912; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 531, 1922.

Pleurotoma (*Genota*) *stearnsiana* Raymond, Nautilus, Vol. 18, p. 1, 1904; Vol. 20, p. 38, pl. 2, figs. 4, 5, 6, 1906.

Bathytoma carpenteriana Gabb, var. *fernandoana* Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 14, pl. 56, fig. 7, 1907; Arnold and Anderson, Bull. 322 U. S. Geol. Survey, p. 58, pl. 23, fig. 7, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, pp. 210, 213, 1914; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, pp. 544, 550, 1922.

"*Bathytoma carpenteriana* Gabb," Dall, Prof. Paper 59 U. S. Geol. Survey, p. 27, pl. 4, fig. 8, 1909.

Bathytoma gabbiana Dall, Prof. Paper 59 U. S. Geol. Survey, p. 28, pl. 4, fig. 1, 1909; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916.

Turris carpenteriana fernandoana Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917.

Cryptoconus stearnsianus Raymond, Dall, Bull. 112 U. S. Nat. Mus., p. 68, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 62, 1927.

Turris (*Bathytoma*) *gabbiana* Dall, Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93, 1922.

Pseudotoma remondii (Gabb), Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 422, pl. 31, fig. 5, 1926.

Shell of small or medium size, biconic, short; whorls with a variable amount of angulation, sometimes the angulation very slight, the whorls being hardly concave above and only moderately convex below, and the suture not far below the angle and inconspicuous so that the whorls merge into each other to form a smoothly conical spire, sometimes the angulation stronger as in *S. carpenterianus* variety *tryonianus;* sculpture of about ten low, widely spaced spiral cords on the body whorl usually with an intercalary between each pair and not infrequently a set of secondary intercalaries between these, the differentiation of the spirals becoming less distinct upwards until the differentiated spirals merge at the angle into the numerous uniform fine spiral threads of the concave area, growth lines moderately strong, and sometimes on the early whorls obscure axial riblets, about fifteen to the whorl; aperture a little longer than half the length of the shell, lenticular, elongate, outer lip simple, with a wide, shallow posterior notch between the angle and the suture, columella smooth, slightly flexuous, with a thin callus, anterior canal short, wide, not differentiated, slightly notched behind; operculum with a terminal nucleus.

Dimensions (of Recent figured specimen): Altitude, 35 mm.; length of aperture, 20 mm.; diameter, 15 mm.

Type specimens: Of *remondii*, at the Academy of Natural Sciences, Philadelphia; of *fernandoanus*, No. 165,303 in the U. S. National Museum; of *stearnsianus*, in the Raymond Collection, Berkeley, California.

Type localities: Of *remondii*, Pliocene of Arroyo San Antonio, near Tomales Bay, just north of San Francisco, California; of *fernandoanus*, Pliocene, Graciosa Ridge, Santa Barbara, California; of *stearnsianus*, Recent, off San Diego.

Upper Miocene: Empire formation of Oregon (Dall, Arnold and Hannibal, Howe); Montesano formation of Washington (Weaver).

Pliocene: Lower Pliocene, Elsmere Canyon (English); type locality of *fernandoanus* (Arnold); loc. 204 S. D. S. N. H., Elsmere Canyon, Los Angeles County, one specimen (H. R. G.); loc. 207 S. D. S. N. H., Elsmere Canyon, Los Angeles County, one unusually large specimen (H. R. G.); loc. 216 S. D. S. N. H., east of Fernando Pass, Los Angeles County, two specimens (H. R. G.); loc. 227 S. D. S. N. H., south of the east end of the Santa Clara Valley, Los Angeles County, one specimen (H. R. G.); middle Pliocene, Merced formation (Gabb according to Dickerson); Etchegoin formation (Nomland); loc. 217*b* S. D. S. N. H., Holser Canyon, north of the Santa Clara Valley, Los Angeles County, one specimen (H. R. G.).

Pleistocene: Lower San Pedro "Saugus" of loc. 246 S. D. S. N. H. east of Timber Canyon, Ventura County, one specimen (U. S. G.).

Living: Monterey to San Diego (Dall).

Gabb's description of this species has been overlooked, partly because the species was assigned to a genus not belonging to this family, partly because the type was erroneously said to come from the Miocene. The species includes individuals ranging in character between two fairly well marked extremes, the comparatively smooth, conic form, and the more angulated form with sharper sculpture and usually riblets on the early whorls. The two extremes appear together in the upper Miocene, the former being figured by Dall (1909) as *carpenterianus*, the latter as *gabbianus*. Gabb had both forms in his original material, for his original figure and description are like those of *fernandoanus* Arnold, but Stewart's lectotype (selected as the type from the original material) is the same as *stearnsianus*. The smooth form alone has been found living, but it is rare and the discovery of the angulated form (which occurs in the Pleistocene) may be expected at any time. In view of the great difficulty of disentangling the two forms nomenclatorially and the probability that these variations are not genetically significant, appearing together and living side by side so long, the attempt is not made here to separate them even as varieties. Their relationship is almost exactly analagous to that between *carpenterianus* and its variety or variational form *tryonianus*. The specimens recorded here from the S. D. S. N. H. localities are all somewhat angulated, the one from 207 being unusually large (altitude 57 mm., length of aperture 30 mm., diameter 25 mm.) but being distinguishable from *carpenterianus* variety *tryonianus* by its short spire, the one from 227 being worn, so as to look like Dall's type of *gabbianus*, and the ones from 204 and 217*b* being higher spired than is usual for this species, slightly suggesting a small *S. riversianus* (Raymond) or a sculptured *Spirotropis fernandoensis* (English), but their other characters show them to be merely unusual variants of this species.

This species is interesting because the less angulated variations so closely resemble *S. filosus* (Lamarck), the type of *Cryptoconus*, practically the only distinguishing feature being the shallowness of the notch. It seems to be older than *carpenterianus*, which was probably derived from it during the Pliocene.

Surculites (*Megasurcula*) *keepi* (Arnold)[1] from the Temblor, middle Miocene, of Topanga Canyon, Los Angeles County, and of Barker's Ranch, Kern County, is another closely allied species. It is a short, broad, biconic species, with a sharp angulation (about two-thirds of the distance up the body whorl) surmounted by a row of sharp, rounded nodes, about twelve to a whorl, the sutures on the upper whorls coming approximately over the angulations of the preceding whorls, so that the spire is smoothly conical like that of the living *remondii;* the lower part of the body whorl is moderately convex, making the aperture broad; the posterior notch is much like that of *remondii;* the columella is nearly straight and stout, recalling that of *Cancellaria tritonidea;* the anterior canal is scarcely defined, slightly notched behind, the notch causing the fasciole that makes the columella irregular. This species is, however, clearly distinguishable from *remondii* by the greater width of the area above the angle, and the shorter, broader aperture. *Surculites* (*Megasurcula*) *condonanus* (Anderson and Martin)[1] from the middle Miocene of Oregon is less easily distinguished, and may not be separable. It is small, short, has fewer (about twelve), stronger, more rounded nodes to the whorl.

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[1] *Pleurotoma* (*Bathytoma*) *keepi* Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 529, pl. 46, fig. 5, 1907, figure reproduced in Bull. 309 U. S. Geol. Survey, pl. 33, fig. 5, 1907.

Bathytoma keepi Arnold, Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 166, 175, 1912.

Surculites (Megasurcula) riversianus (Raymond)

Pleurotoma (*Genota*) *riversiana* Raymond, Nautilus, Vol. 18, p. 14, 1904; Vol. 20, p. 39, pl. 2, fig. 9, 1906.

Shell of medium size, very high spired; whorls moderately shouldered, the shoulder occurring on the spire whorls nearly two-thirds of the distance above the suture, with a narrow, slightly concave area above it and an almost flat, convex area below; sculpture of sharp spiral threads, finer above the angle, crossed by growth lines of nearly equal strength; aperture defective.

Dimensions (from Raymond): Length of shell, 59 mm.; of aperture and canal, 30 mm.; of body whorl, 41 mm.; maximum diameter, 20.5 mm.; divergence, 30°.

Type specimen: Probably in the Raymond Collection, Berkeley, California.

Type locality: "Pliocene" of Santa Monica.

Pleistocene: Type locality, only one specimen known.

This peculiar specimen is characterized by its unusually high spire and the elevated position of its angulation. These two features, it will be noticed are really but a single character, for they are both due to the unusually high angle of gyration. Perhaps also the slenderness of the specimen is partly exaggerated by the fact that the body whorl is broken off. So little is known about this form that it is hard to find its proper place in the classification, but it is probable that it should be assigned either to *S. remondii* or to *S. carpenterianus* as a variety or monstrosity.

Surculites (Megasurcula) carpenterianus (Gabb)

Plate 25, Figures 4*a*, 4*b*

Pleurotoma (*Surcula*) *carpenteriana* Gabb, Proc. Calif. Acad. Sci., Ser. 1, Vol. 3, p. 183, 1865; Geol. Surv. Calif., Palæo., Vol. 2, p. 5, pl. 1, fig. 8, 1866; Merriam, List of Type Specimens at the Univ. of Calif., 1895.

Surcula carpenteriana Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 72, 1868-9; Tryon, Man. Conch., Vol. 6, p. 239, pl. 7, fig. 3, 1884; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 266, in part, 1888; Keep, West Coast Shells, p. 57, fig. 41 (frontispiece and illustration on cover), 1888, 1892.

Genota carpenteriana Gabb, Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 303, 1889.

Pleurotoma (*Dolichotoma*) *carpenteriana* Gabb, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 207, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 202, 1903.

Pleurotoma carpenteriana Gabb, Keep, West American Shells, p. 157, fig. 140, 1904.

Pleurotoma (*Genota*) *carpenteriana* Gabb, Raymond, Nautilus, Vol. 20, p. 37, pl. 2, figs. 1, 3, not 2, 1906.

? Not *Bathytoma carpenteriana* Gabb, Dall, Prof. Paper 59 U. S. Geol. Survey, p. 27, pl. 4, fig. 8, 1909; = *remondii.*

Bathytoma clarkiana Rivers, Bull. So. Calif. Acad. Sci., Vol. 12, no. 2, p. 29, unnumbered plate, July, 1913; Nautilus, Vol. 28, p. 64, pl. 3, figs. B, C, Oct., 1914.

Turris (*Bathytoma*) *carpenteriana* (Gabb), Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 203, 1916; Howe, Vol. 14, p. 93, 1922.

Bathytoma carpenteriana Gabb, Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 231, 243, 255, 1916; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 343, pl. 37, fig. 6, 1918.

Turris carpenteriana (Gabb), Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 221, 1917.

Cryptoconus carpenterianus Gabb, Dall, Bull. 112 U. S. Nat. Mus., p. 68, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Carson, Vol. 25, p. 49, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 63, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pseudotoma carpenteriana (Gabb), Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 423, 1926.

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[1] *Bathytoma condonana* Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 89, pl. 7, fig. 8 (*condoniana*), 1914.

Shell large, high spired, biconic; whorls with a variable amount of angulation, sometimes almost smoothly rounded with hardly any concavity above the angle, sometimes with a strong angle surmounted by more or less distinct nodes, the increase in the size of the whorls usually somewhat accelerated as the shell approaches its full growth so that the outline of the spire is slightly concave and the young specimens are more slender than the adults, spiral sculpture of numerous cords varying in strength as in *remondii*, crossed by more or less prominent growth lines; aperture varying in length from half to a little more than half the length of the shell, with practically the same features as those of *remondii.*

This species goes through a series of variations analagous to those of *remondii.* It is distinguishable from *remondii* by its higher, more slender spire, and usually by its larger size. As pointed out above, it is probably a more recent split from the *remondii* stock, and the two may be hard to distinguish in the Pliocene. For this reason a number of the reported occurrences have to be questioned until specimens can be examined. This species does not range back so far as it was formerly thought to.

Variety **carpenterianus**, s. s.

Shell large, not heavy, high spired, biconic, without nodes or angulations, aperture relatively long.

Dimensions (of large living specimen): Altitude, 100 mm.; length of aperture, 55 mm.; diameter of body whorl, 37 mm.

Type specimens: Of *carpenterianus*, at the University of California, No. 11,996; of *clarkianus*, cotypes, the larger, No. 10, and the smaller, No. 11, in the type collection of the San Diego Society of Natural History.

Type localities: Of *carpenterianus*, "post-Pliocene" of Santa Barbara; of *clarkianus*, Pleistocene of Santa Monica.

Pliocene: ? Lower Etchegoin formation (Nomland); ? San Diego well (Dall in Arnold, 1903); ? Merced and Purisima of middle California (Martin); Fugler's Point, Santa Barbara County (Carson), — specimens examined, typical; Coos conglomerate, Coos Bay, Oregon (Howe).

Pleistocene: Las Posas zone, "Saugus" of Ventura Co. (from Arnold; Waterfall); lower Quaternary of Magdalena Bay, Lower California (Jordan); Pleistocene of Santa Monica (Rivers); Pacific Beach, San Diego (Cooper; Arnold); upper San Pedro series, Palos Verdes, of San Pedro and vicinity (Arnold).

Living: Bodega Bay, California, to San Pedro (Dall).

Surculites (Megasurcula) carpenterianus (Gabb) variety **tryonianus** (Gabb)

Pleurotoma (Surcula) tryoniana Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 6, pl. 1, figs. 9, 9*a*, 1866; Merriam, List of Type Specimens at the Univ. of Calif., 1895.

Surcula tryoniana Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 72, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mining Bureau, p. 266, 1888.

Surcula carpenteriana var. *tryoniana* Gabb, Baker, Nautilus, Vol. 16, p. 41, 1902.

Pleurotoma (Dolichotoma) tryoniana Gabb, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 203, 1903.

Pleurotoma (Genota) tryoniana Gabb, Raymond, Nautilus, Vol. 20, p. 38, pl. 2, figs. 7, 8, 1906.

Turris (Bathytoma) tryoniana Gabb, Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 203, 1916; Moody, Vol. 10, p. 44, 1916.

Turris tryoniana (Gabb), Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1916.

Cryptoconus tryonianus Gabb, Dall, Bull. 112, U. S. Nat. Mus., p. 68, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 61, 1927.

Pseudotoma tryoniana (Gabb), Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 423, 1926.

Shell like that of the typical form but somewhat heavier and with more strongly angulated whorls, the angle being accentuated by a row of small rounded nodes, about twelve to a whorl, aperture about half as long as the shell.

Dimensions (of living specimen): Altitude, 87 mm.; length of aperture, 43 mm.; diameter of body whorl, 33 mm.

Type specimen: At the University of California, No. 11,997.

Type locality: "Post-Pliocene" of San Pedro.

Pliocene: ? Jacalitos and lower Etchegoin, lower Pliocene (Nomland); ? Fernando formation, middle or upper Pliocene of Los Angeles (Moody); Santa Barbara horizon, upper Pliocene, of Santa Barbara (from Arnold).
Pleistocene: Upper San Pedro series, Palos Verdes, of San Pedro (Arnold; probably also Gabb and Cooper).
Living: San Pedro to Todos Santos Bay, Lower California (Dall).

The variety *tryonianus* is like the form *fernandoanus* of *remondii* in that it is more shouldered, and it has a tendency to form nodes, as the latter has to develop riblets. It is further like the varieties of *remondii* in that it is probably of no significance, but unlike them it has always been clearly separated. The separation is preserved here principally for descriptive purposes and because it is easy to make. The intermediate specimens are more common than the *tryonianus* extreme.

Surculites (**Megasurcula**) **carpenterianus** (Gabb) variety **tremperianus** (Dall)

"Pleurotoma (Genota) carpenteriana Gabb," Raymond, Nautilus, Vol. 20, p. 38, in part, pl. 2, fig. 2 only, 1906.
Bathytoma tremperiana Dall, Nautilus, Vol. 24, p. 109, 1911.
Cryptoconus tremperianus Dall, Bull. 112 U. S. Nat. Mus., p. 68, pl. 12, fig. 5, 1921; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 62, pl. 11, fig. 12, 1927.

Shell like that of the typical variety but heavier and with the increase in the size of the later whorls not accelerating, so that the body whorl is relatively smaller than in the typical variety and the aperture relatively shorter.

Dimensions (of Pleistocene specimen): Altitude, 59 mm.; length of aperture, 28 mm.; diameter of body whorl, 19 mm. This specimen is extreme.

Type specimen: In the U. S. National Museum.

Type locality: Off San Pedro, California (*fide* Oldroyd).

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California (Jordan); upper San Pedro series, Palos Verdes, of San Pedro (Arnold Collection).
Living: Point Año Nuevo, middle California, to Cedros Island, Lower California (Dall).

Like *tryonianus*, this variety is probably of little or no significance. It may be ecologic, living in exposed positions; or, as Mrs. Oldroyd remarks, it may be partly pathologic, most of the specimens showing signs of having been injured. It is very close to two earlier named forms: *clarkianus* Rivers, which although narrow and high spired, is here included with the typical variety because of its longer aperture; and *cooperi* Arnold, which has the short aperture and thick shell but has a sharper shoulder. The variety *cooperi* is a rare extreme of this type of variation and it is very probable that *tremperianus* should be classed as a synonym of it.

Surculites (**Megasurcula**) **carpenterianus** (Gabb) variety **cooperi** (Arnold)

Plate 25, Figure 3

Pleurotoma (Dolichotoma) cooperi Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 203, pl. 7, fig. 3, 1903.
Pleurotoma (Genota) cooperi Arnold, Raymond, Nautilus, Vol. 20, p. 38, pl. 2, fig. 10, 1906.

Shell like that of the typical variety but heavier, with a shorter aperture and a sharp shoulder, the area above the shoulder being strongly concave, and the shoulder (on the type specimen at least) surmounted by small indistinct nodes about fifteen to the whorl, practically obsolete on the body whorl.

Dimensions (of type): Altitude, 64 mm.; length of aperture, 32 mm.; diameter of body whorl, 24 mm.

Type specimen: In the Stanford University type collection, No. 426.

Type locality: Upper San Pedro series, Palos Verdes, of San Pedro, only the type found.

Pliocene: ? Loc. 202*m*, S. D. S. N. H., basal Pliocene of Elsmere Canyon, Los Angeles Co., one specimen (H. R. G.).

Pleistocene: Type locality; Pleistocene of Santa Monica, Rivers Collection, one specimen (Raymond).

The nodes on the type specimen of this variety are more numerous and smaller than those on the variety *tryonianus*, and the angle is sharper, but the type is an extreme specimen. The specimen figured by Raymond shows how close this variety is to the others. It is most probable that the variety *tremperianus* should be treated as a synonym. The specimens reported by Nomland from the Etchegoin as *tryonianus* may be *cooperi*, and the specimen recorded above from loc. 202 may belong to either variety.

Surculites (*Surculites*) *wynootcheensis* (Weaver), a Miocene fossil from Washington, is so strikingly similar to *cooperi* in its general characters, and also to *S.* (*Pseudotoma*) *intortus* (Brocchi), the type of the subgenus *Pseudotoma*, that it is here figured (plate 25, figure 2) side by side with the others to show the relationship. There can be little doubt that all three belong to the same genus.

Subgenus **PSEUDOTOMA** Bellardi, 1875

Pseudotoma Bellardi, Bull. Società Malac. Ital., Vol. 1, p. 20, 1875; Mem. R. Accad. Sci., Torino, Ser. 2, Vol. 29, pp. 209-222, 1878; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 145, 1896; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 423, in part, 1926.

Type (by monotypy), *Murex* (*Pleurotoma*) *intortus* Brocchi, figured by Bellardi, Mem. R. Accad. Sci., Torino, Ser. 2, Vol. 29, p. 214, pl. 7, fig. 10, 1878; by Cossmann, Ess. Paléo. Comp., Vol. 2, pl. 8, fig. 11, 1896; and by Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 212, pl. 26, figs. 11-14, 1915; also figured here, plate 25, figures 1*a*, 1*b*; Oligocene to upper Pliocene of Europe (Harmer).

Shell of variable size and shape, the type species being large and turreted, practically indistinguishable from typical *Surculites* except that the whorls are slightly more inflated, the angles more rounded, and the area above the angle sloping concavely upward instead of having a tabulation sharply marked off from a vertical sutural collar; other variations of *Pseudotoma* lacking the angle almost entirely and grading into *Cryptoconus*.

Geologic range: Eocene to Recent of Europe; Eocene of Australia (*fide* Cossmann).

Bellardi has described and figured in his monograph of Pleurotomas, 1878, a series of species of *Pseudotoma* from the Italian Miocene that vary in form from the large, strongly shouldered, conspicuously nodose *intorta* to the small, round-whorled, smooth *lævis* (erroneously taken as type by Cossmann). In the same collection is another species that is almost surely a *Clinura*, "*P.*" *bonellii*. Between these three extremes are a number of representatives of intermediate stages. Cossmann and Pissarro figure in their "Iconographie complète des Coquilles fossiles de l'Éocène des Environs de Paris," Vol. 2, pl. 49, 1907-1913, a similar series of species of *Cryptoconus* and a few which they assign to *Pseudotoma*. Although there do not happen to be in this Eocene series any species that have quite so much of a shoulder as *intortus*, there are some with deep notches that are as large and have the same form (except for the notch) as some of Bellardi's species that are intermediate between the extremes *lævis* and *intortus;* and there are some species of the size and shape of *C. filosus* that are assigned by Cossmann and Pissarro to *Cryptoconus* but have a shallow notch, and there are some with notches of intermediate depth. This kind of intergradation can be found between most of the subgenera of *Surculites*, and this is the reason why it is not thought desirable to separate these groups generically.

The nature of the relationship between *Pseudotoma* and *Megasurcula* is not quite clear. The two may be parallel offshoots from the Eocene *Surculites* stock; or *Pseudotoma* may have been derived from a portion of the stock close to the typical form and *Megasurcula* directly from *Clinura*. The latter supposition is the more probable. The species reported by Cossmann (1896) from the Claiborne, Eocene of Alabama, as *Pseudotoma* is more probably a *Megasurcula*, if the two subgenera can be distinguished at all.

Subgenus **CRYPTOCONUS** von Koenen, 1867

Cryptoconus von Koenen, Palæontographica, Vol. 16, p. 167, Sept., 1867, list includes *Pleurotoma filosa* Lamarck (p. 169) and several other species; Arch. Naturg., Vol. 2, p. 211, 1880; Cossmann, Ann. Soc. Roy. Malac. Belg., Vol. 24, p. 235, 1889, *Pleurotoma filosa* Lamarck designated as type; Ess. Paléo. Comp., Vol. 2, p. 147, 1896; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 319, 325, 1918, in part.

Type (by subsequent designation, Cossmann, 1889), *Pleurotoma filosa* Lamarck, Eocene of Europe, figured by von Koenen, Palæontographica, Vol. 16, pl. 11, fig. 8, 1867, by Cossmann, Ess. Paléo. Comp., Vol. 2, p. 148, pl. 7, figs. 20-21, 1896, and by Cossmann and Pissarro, Icon. Comp. Coq. Fos. Env. Paris, Vol. 2, pl. 49, figs. 216-1, Paris, 1907-13.

Shell of medium size, biconic, shoulders obscure, body whorl rounding down in a smooth curve to the base, notch rounded but narrower and deeper than in the typical and the other subgenera of *Surculites*, a little distance below the suture, spiral sculpture sometimes present on the fasciolar area as well as over the rest of the whorl, fasciolar area narrower than in the other subgenera, anterior canal short, poorly defined, merely a continuation of the *Conus*-like aperture.

Geologic range: Eocene and Oligocene of Europe.

Cryptoconus is difficult to separate from two groups, besides typical *Surculites*, that have older names: *Conorbis* Swainson[1] and *Genota* H. and A. Adams. Von Koenen explains fully how to distinguish it from the former, and Cossmann (1896) summarizes his argument. In *Conorbis* all of two shell layers and part of the third in the interior parts of the upper whorls are resorbed as in *Conus*, and there is a slight difference in the shape of the columella. Hence *Conorbis* is generally classed with the *Conidæ*, although in external form it is practically identical with *Cryptoconus*. The writers have not been able to examine *Conorbis dormitor*, but they assume that this distinction is significant. It is explained below that *Genota* is distinguished by its notch, which is situated on or near the shoulder and is sharper and more triangular in shape.

The notch of *Cryptoconus* retains to a greater extent than do the notches of the other subgenera of *Surculites* the form of the notch of the ancestral *Turricula*. *Cryptoconus* is probably closely related to the ancestors of *Genota*. It is easily distinguishable from the typical *Surculites* by its much weaker angle and its deeper notch, but it is less easily distinguishable from the intermediate subgenera, *Clinura* and *Pseudotoma*. The writers believe that Dall was correct in classifying the California living and later Tertiary species in the same genus as *Cryptoconus*, and his precedent in using *Cryptoconus* as a genus name for those species is not followed here only because of the discovery of an earlier name belonging to the same generic group. *Pseudotoma* is later than *Cryptoconus* and can only be distinguished subgenerically by the slightly shallower notch and wider fasciolar area. Even this separation may not be worth while to maintain, for the two intergrade completely in the early Tertiary of Europe. As pointed out by Dall, the smaller living Pacific coast species now assigned to *Megasurcula*, *S. remondii* (Gabb), (formerly known as *stearnsianus* Raymond), has practically the same shape as *S. filosus* (Lamarck), which it resembles, except for the shallower notch, much more closely than it does the type of *Pseudotoma*.

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[1] *Conorbis*, Swainson, Treat. Malac., p. 312, 1840, type (by monotypy) *C. dormitor* Sowerby. See also Melvill, Proc. Malac. Soc. London, Vol. 6, pp. 170-173, 1904.

Genus GENOTA H. and A. Adams, 1853

Genota H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 89, 1853, original list includes two species only, *mitriformis* Wood and *papalis* Reeve; Tryon, Struct. and Syst. Conch., Vol. 2, p. 183, 1883; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 327, 1918; Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, pp. 206, 207, 1925.

Genotia H. and A. Adams emended, Fischer, Man. Conchyl., p. 589, 1883, "Génot, nom donné par Adanson au type du genre" (Adanson's Le Génot, described and figured in the Hist. Nat. du Senegal, p. 145, pl. 9, figs. 35, 1757, is *Murex mitriformis* Wood); Tryon, Man. Conch., Vol. 6, pp. 154, 174, 1884, says practically the same thing as Fischer; Cossmann, Ess. de Paléo. Comp., Vol. 2, p. 143, 1896, type *Buccinum mitriforme* Wood.

Type (by subsequent designation, Fischer, 1883; Cossmann, 1896, etc.), *Murex mitriformis* Wood. This species is illustrated by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 4, fig. 23, 1843, and by Tryon, Man. Conch., Vol. 6, p. 174, pl. 7, fig. 1, 1884. It is also shown here, plate 25, figure 17. According to Tryon, *papalis* Reeve, the other species listed by the Adams brothers, is merely a variety.

Shell of medium or large size, biconic, elongate; whorls shouldered, the shoulder appearing about the middle of the spire whorls and near the top of the body whorl; spiral sculpture always present and sometimes axial riblets; aperture from half to three-fifths length of shell, long, narrow, the notch and the anal fasciole *Turris*-like, on or just above the shoulder, sharp, triangular; operculum unguiculate (according to Tryon, lacking according to Thiele).

The name *Genota* is the oldest name applied to the group of biconic *Turridæ* now referred to *Genota, Bathytoma, Surculites, Cryptoconus, Pseudotoma,* etc., and looking somewhat alike. The first two have the notch on or near the shoulder, and should be separated only as subgenera; the last three have a more rounded notch, nearer the suture, and should likewise be separated from each other only as subgenera. The relation between the two groups is like that between *Turris* and *Turricula.* Although the first two names have been applied to California species, they appear to have no proper place here unless the oldest name be used for both groups taken together. They are treated in this paper only to show why they are no longer used in the later Tertiary of California.

Subgenus **GENOTA,** s. s.

Shell of medium size, the shoulder on the whorls not carinated, sculpture of uniform, not conspicuous spiral lines and on the early whorls numerous chevron-shaped riblets formed by the accentuation of growth lines, aperture about three-fifths length of shell, with nearly straight and parallel sides.

Geologic range: Eocene to Pliocene of Europe (*fide* Cossmann).

Living distribution: West Africa.

Subgenus **BATHYTOMA** Harris and Burrows, 1891

Dolichotoma Bellardi, Bull. Società Malac. Italiana, Vol. 1, p. 21, 1875, not *Dolichotoma* Hope (Coleoptera), 1839.

Doligotoma Weinkauff, Jahr. Mal. Gesell., p. 8, 1876, merely a transliteration.

Bathytoma Harris and Burrows, Eoc. and Olig. Paris Basin, p. 113, 1891, new name for *Dolichotoma* Bellardi, not Hope; Cossmann, Ess. de Paléo. Comp., Vol. 2, p. 101, 1896; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, Australasian, p. 48, 1897; Tate, Proc. Roy. Soc. N. S. W., Vol. 31, p. 398, 1898; Hedley, Rec. Austral. Mus., Vol. 13, p. 231, 1922.

Type (by monotypy), *Murex cataphractus* Brocchi, Pliocene, figured by Cossmann, *op. cit.*, pl. 8, figs. 12, 14.

Shell somewhat larger than that of the typical subgenus, with a more prominent shoulder marked by a beaded carina as in *Gemmula;* sculpture predominantly spiral; aperture only half as long as the shell and somewhat wider than in the typical subgenus, anterior canal slightly differentiated.

Geologic range: Eocene of eastern United States and Australia; Eocene to Pliocene of Europe (*fide* Cossmann).

Living distribution: Japan and the Philippines.

This group is distinguished from the typical form by its beaded carinate suture, its larger size, and its larger, less straight-sided aperture; from *Gemmula* by its more compact outline and its short, hardly differentiated anterior canal; and from *Surculites* by its notch. *Genota luhdorfi* Lischke, living in Japan, is a characteristic species, except that its shell is thin.

Genus **TURRIS** Bolten, 1798

Buccinum Turris babylonica Rhumphius, etc., pre-Linnæan.

Murex sp., Linnæus, Syst. Nat., Ed. 10, p. 753, 1758.

[*Buccinum*] *Turris babylonica* R., P. L. S. Müller, Deliciæ Naturæ Selectæ, Vol. 1, p. 129, 1766, the name *Turris babylonica* being used, after Rhumphius, in a specific sense only, see Iredale, Proc. Malac. Soc. London, Vol. 15, p. 78, 1922, and Dautzenberg, Moll. Camp. Sci. Albert 1, Prince de Monaco, Vol. 72, p. 27, 1927.

[*Fusus*] *Turris babylonica* Chemnitz, Neues Syst. Conchyl. Cab., Vol. 4, pp. 147, 166, etc., 1780, the name used in a specific sense only, as it was used by Müller and others.

Turris (Humphrey) Hwass, Museum Calonnianum, 1797, *Turris babylonica* included; type cited by Gray, Proc. Zool. Soc. London, p. 134, 1847, *Murex babylonicus*. The Museum Calonnianum was ruled out by the International Commission on Zoological Nomenclature as nomenclatorially not available.

Turris Bolten, Museum Boltenianum, p. 123, 1798, species include *T. babylonica* with *Murex babylonus* Gmelin, and Martini, Vol. 4, pl. 143, figs. 1331, 1332 cited in the synonymy; Meek, U. S. Geol. Survey of the Territories, Vol. 11, p. 380, 1876, type cited *Murex babylonius* Linnæus; Dall, Prof. Paper 59 U. S. Geol. Survey, p. 24, 1909; Proc. U. S. Nat. Mus., Vol. 54, pp. 314, 332, 1918.

Pleurotoma Lamarck, "Prodr.", Mém. Soc. Hist. Nat., Paris, Ser. 1, Vol. 1, p. 73, 1799, type (by monotypy) *Murex babylonius* Linnæus; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 75, 1896; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, Australasian, pp. 37, 38, 1897; etc., etc.

Lophiotoma Casey, Trans. Acad. Sci., St. Louis, Vol. 14, p. 130, 1904, *Pleurotoma tigrina* Lamarck included; type cited by Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 146, 1928, *Pleurotoma tigrina* Lamarck.

Turris Müller, 1766, Hedley, Rec. Australian Mus., Vol. 13, p. 214, 1922.

Type: Turris babylonica Bolten ex Rhumphius, Chemnitz, Hwass, etc., = *Murex babylonius* Linnæus and Gmelin, cited for *Turris* Humphrey (= Hwass) by Gray, 1847, and for *Turris* Bolten by Meek, 1876. *Turris babylonia* (Linnæus) is figured by Chemnitz, Neues Syst. Conchyl. Cab., Vol. 4, p. 166, pl. 143, figs. 1331, 1332, 1780; by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 1, species 5; by Tryon, Man. Conch., Vol. 6, p. 162, pl. 1, figs. 1, A-C, 1884; etc. The specific name should be spelled after Linnæus without a "*c*." *T. babylonia* is living in the Philippine Islands and the East Indies.

Shell of medium or large size for the family, fusoid, normally with a high spire and a long or moderately long, narrow anterior canal; whorls sculptured with spiral threads, ridges, or cords, rough or smooth, sharp or rounded and variously arranged; posterior notch deep, usually parallel-sided with a square end, situated on the periphery of the whorl some distance below the suture, outer lip lirate within, operculum with a terminal nucleus.

Geologic range: Eocene to Recent.

Distribution: Tropical waters of all oceans.

This genus is closely related to *Turricula* Schumacher, from which it is distinguished by its deep, angular posterior sinus, and by the distance of the sinus below the suture. The sculpture is always spiral in *Turris;* it may be roughened and mottled and even finely beaded on the most prominent carina, or the carinæ may be smooth and glossy as in the type; but so far as the writers know the sculpture is never lacking as in the type of *Turricula*, nor are there nodes on the angle as in *Turricula kaderleyi* (Lischke). The opercula are also different, but this difference is not here considered of very great importance.

The only essential difference, however, which is the shape and position of the notch, is not always definite, and it is somewhat questionable whether the two groups should be separated generically. Harris found that in the early Tertiary they run together and are practically impossible to distinguish. It is to be noted that many of the genera and subgenera related to *Turris* and *Turricula* and either descended from them or from a common ancestor may be arranged into two parallel series so that in the groups placed opposite each other there will be found species which are alike in every respect except in the shape and position of the notch, and at the same time each may differ considerably in other characters from the most closely related forms in its own series. This arrangement is in part as follows:

Turris notch	*Turricula* notch	General appearance
Turris	*Turricula*	Large fusiform
Genota *Bothytoma*	*Surculites*, etc.	Large, heavy, biconic.
Cochlespira (*Rouaultia*)	*Ancistrosyrinx*	Long anterior canal, spinose keel.
	Aforia, etc.	Long anterior canal, keel obsolete.
Hemipleurotoma (*Cryptogemma*)	*Pleurotomoides* (*Pleurotomella*)	Medium size, axial and spiral sculpture, moderate canal.
Moniliopsis	*Spirotropis*	Medium size, short canal, sculpture weak.
Taranis	*Teres*	Rather small, spiral sculpture strong, axial sculpture finer.

This table does not attempt to show all the groups that belong in the two series, nor to indicate the changes in the characters of the notches in the different groups. It is included merely to illustrate the parallelism of form. Although it is usually possible to separate the forms of the opposite groups near the head of the list, it becomes more and more difficult to do so with the forms that belong near the foot of the list; for the notches become smaller, less conspicuous, and less distinct. It is difficult, if not impossible, to explain this parallelism on any theory of evolution involving the assumption that the two stocks developed side by side independently. On the other hand, it is easy to see that if all the forms belong to a single stock which had originally a notch varying in character from one extreme to the other, each of the distinctive groups evolved from it may have a notch similarly varying in character from one extreme to the other. Hence it is concluded that the form of the notch, although useful for purposes of classification, is not always to be trusted alone as a final criterion for making separations; and where similar genera are here separated principally on the basis of the notch, the separation is made with considerable hesitation. Similar remarks might apply to genera that have a *Clavus* notch.

Turris grades into *Hemipleurotoma* through the subgenus *Gemmula;* but *Hemipleurotoma* is a more delicate, smaller, deeper water form, with a shorter, less distinctly differentiated anterior canal, and can be readily distinguished. *Pleuroliria* de Gregorio,[1] *Polystira* Woodring,[2] and probably others are closely related, but the writers have not had access to enough material to be able to tell whether they are distinct or not.

Although the name *Turris* has been used considerably for Pacific coast species, probably none of the species so called that have been found in California or northward in beds younger than the Oligocene belong to this genus.

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[1] *Pleuroliria* de Gregorio; Ann. Géol. Paléo., Vol. 7, p. 38, Palermo, 1890, type *P. supramirifica* de Gregorio, *loc. cit.*, = ? *Pleurotoma cochlearis* Conrad var., Eocene of Alabama; Casey, Trans. Acad. Sci., St. Louis, Vol. 14, p. 130, 1904; Cossmann, Ess. Paléo. Comp., Vol. 7, p. 220, 1906.

[2] *Polystira* Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 145, 1928, type (by original designation) *Pleurotoma albida* Perry, fossil and living in Florida and the West Indies, illustrated by Dall, Trans. Wagner Inst. Sci., Phila., Vol. 3, p. 28, pl. 4, fig. 8*a*, 1890.

Subgenus **TURRIS**, s. s.

Shell without beads on the slit-band.

Species illustrating the typical subgenus include besides *babylonia: grandis* (Gray), *variegata* (Kiener), *tigrina* (Lamarck), *garnonsii* (Reeve), *spectabilis* (Reeve), *crispa* (Lamarck), *picta* (Beck in Reeve), *indica* Bolten, *virgo* (Lamarck), *deshayesii* (Doumet), *oxytropis* (Sowerby). *T. babylonia* has the smooth carinæ of the last four species mentioned, but the mottled color of the others. *T. abbreviata* (Reeve), a small, very short species, is shown by its notch and markings to belong here, though its stunted shape is misleading. *T. cingulifera* (Lamarck) also belongs here in spite of its short anterior canal; and *T. fascialis* (Lamarck) should probably be placed here.

Subgenus **GEMMULA** Weinkauff, 1876

Gemmula Weinkauff, Jahrb. der Deutschen Mal. Gesell., Vol. 2, p. 287, 1876, list includes *gemmata* Hinds; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 62, 1896; Casey, Trans. Acad. Sci., St. Louis, Vol. 14, p. 133, 1904; Hedley, Rec. Australian Mus., Vol. 13, p. 217, 1922.

Type (by subsequent designation, Cossmann, 1896), *Pleurotoma gemmata* Hinds in Reeve, Conch. Icon., Vol. 1, *Pleurotoma,* pl. 10, species 83, April, 1843; Hinds, Proc. Zool. Soc. London, p. 37, October (*fide* Hedley), 1843, living Magdalena Bay, Lower California, according to Hinds, but Tryon doubts the locality and refers it to the western Pacific and Indian Ocean.

Shell like that of the typical subgenus but with a beaded anal fasciole.

Geologic range: Eocene to Recent.

Distribution: Tropical waters of the western Pacific, Indian Ocean, Red Sea, etc., occurrence along the west coast of Mexico doubted.

Although the living occurrence of this subgenus along the Pacific coast of North America is questioned, there are in the Eocene of California and Washington species which undoubtedly belong here. Most of them have been recorded as *Pleurotoma, Turris,* or *Surcula monilifera* Cooper, not *Turris* (*Gemmula*) *monilifera* (Pease). In spite of its antiquity, this subgenus is still very close to the typical subgenus. It is more distantly related to *Hemipleurotoma.*

Genus COCHLESPIRA Conrad, 1865

Cochlespira Conrad, Amer. Journ. Conch., Vol. 1, p. 19, 1865, species listed, *Pleurotoma cristata* Conrad and *C. engonata* Conrad; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 68, 1896, type cited *C. engonata* Conrad; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 164, 1928.

Rouaultia Bellardi, Mem. R. Accad. Sci. Torino, Ser. 2, Vol. 29, p. 223, 1878, list consists of *Pleurotoma subterebralis* Bellardi in E. Sismond, *R. lapugyensis* (May), and in section 2, *R. bicoronata* Bellardi; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 95, 1896, type cited *Pleurotoma subterebralis,* Miocene of Italy, figured pl. 6, figs. 16-17, 1896; not *Rouaultia* Monterosato, 1884.

Cochlespiropsis Casey, Trans. Acad. Sci., St. Louis, Vol. 14, p. 143, 1904, list consists of *engonata* Conrad and *blanda* Casey; Cossmann, Ess. Paléo. Comp., Vol. 7, p. 221, 1906, type cited *Pleurotoma engonata* Conrad.

Not "*Cochlespira* Conrad" Casey, Trans. Acad. Sci., St. Louis, Vol. 14, p. 143, 1904, type *C. cristata* Conrad; Cossmann, Ess. Paléo. Comp., Vol. 7, p. 221, 1906; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 257, 1908; = *Ancistrosyrinx* Dall.

Type (by subsequent designation, Cossmann, 1896), *Cochlespira engonata* Conrad, Amer. Journ. Conch., Vol. 1, pp. 20, 210, pl. 21, fig. 12, 1865; Cossmann, Ess. Paléo. Comp., Vol. 7, pl. 14, fig. 13, 1906, Eocene of Texas.

Shell of medium or small size, turreted, with the posterior sinus on the periphery; sculpture of obscure spiral lines and sometimes beading on the periphery; columella fairly long, sometimes with an obscure plication.

Geologic range: Eocene of southeastern United States; Miocene of Italy.

This genus looks very much like a small *Surculites*, especially the subgenus *Clinura*, but it is distinguishable by its sharp triangular notch on the periphery. It has been confused with *Ancistrosyrinx*, but can be separated from that genus also by its notch. Cossmann determined the synonymy of *Rouaultia* by comparing specimens of the type species.

Genus ANCISTROSYRINX Dall, 1881

Candelabrum Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 5, p. 61, 1878, single species *C. cathedralis* Dall, *nomen nudum;* not *Candelabrum* Blainville, 1830.

Ancistrosyrinx Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 9, p. 54, 1881; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 71, 1896; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 164, 1928.

"*Cochlespira* Conrad" Casey, Trans. Acad. Sci., St. Louis, Vol. 14, p. 143, 1904, type *C. cristata* Conrad; Cossmann, Ess. Paléo. Comp., Vol. 7, p. 221, 1906, type *C. cristata* Conrad, figured pl. 14, fig. 20; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 257, 1908, type *Pleurotoma cristata* Conrad.

Type (by monotypy), *Candelabrum cathedralis* Dall + *Ancistrosyrinx elegans* Dall, described in the Bull. Mus. Comp. Zool., Harvard Coll., Vol. 9, p. 54, 1881, figured Vol. 18, p. 78, pl. 38, fig. 3, 1889, repeated in Bull. 37 U. S. Nat. Mus., pl. 38, fig. 3, 1889, 1903; living, Florida reefs, 805 fathoms.

Shell of medium size, very strongly turreted, with a long anterior canal; whorls tabulated, with a nodose, sometimes elegantly spinose keel-like periphery, sculptured below with low spiral cords crossed by prominent growth lines; posterior notch deep, rounded, close to the suture, and in addition a triangular pseudo-notch out at the periphery; operculum with a terminal nucleus.

Geologic range: Eocene to Recent of Europe and of the United States.

Distribution: Florida, West Indies, Panama, and the Orient (*fide* Woodring).

This very distinctive genus has a long range and a wide distribution. It is represented in the Eocene of Mississippi by *Pleurotoma* (*Ancistrosyrinx*) *columbaria* Aldrich, according to Dall, and in the Pacific by *Pleurotoma cedo-nulli* Reeve. The latter species, of which the locality is uncertain, is not a *Columbarium* as Tryon supposed, for *Columbarium* has no sinus. The less characteristic species have been confused with *Cochlespira* Conrad, but the latter as restricted by Cossmann, 1896, does not have the sutural posterior sinus, nor such a long anterior canal. It is probably also related to *Surculites*, but has a much deeper notch, and a much slenderer, more elegant shape, with a much longer anterior canal.

Genus LEUCOSYRINX Dall, 1889

Leucosyrinx Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 18, p. 75, 1889; Vol. 43, p. 256, 1908.

Type (by original designation), *Pleurotoma* (*Pleurotomella*) *verrillii* Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 9, p. 57, 1881; Vol. 18, p. 75, pl. 10, fig. 5, 1889; living, Gulf of Mexico, etc., in deep water (150 to 940 fathoms).

Shell of medium or large size, thin, with a high, usually somewhat turreted spire and a long or moderately long anterior canal; whorls shouldered or keeled, with a broad, slightly concave anal fasciole above, convex below, sculpture of spiral lines or cords of varying prominence, occasionally with nodes on the shoulder; posterior notch between the shoulder and the suture, usually broad, rounded, fairly deep, closer to the shoulder than the suture; operculum of varying form.

Distribution: Abyssal regions of both the Atlantic and the Pacific.

This genus includes most of the large, thin-shelled abyssal forms. It has the notch and general shape of *Turricula*, and it appears to be a descendant of *Turricula* that adapted itself to a deep-water habitat. It is distinguished from *Turricula* by its thinner shell, more inflated appearance, various modifications of the operculum, etc. As explained above, no supreme faith is placed by the writers in the value of the operculum or of any other single character for showing genetic relationships. The development of the operculum may be a secondary character, dependent upon the shape of the aperture, and the operculum may change its character because of environmental influences late in the history of a group. When adapting itself to deep-water conditions, this group appears to have modified the operculum of the primitive species of *Turricula*, which may or may not have been like that of the living *Turricula*, and some of the species appear to have acquired a paucispiral operculum or to have retained it longer than others. As evolution proceeds more slowly in abyssal regions, the opercula of this group may still include remnants of the form of the early Turrid opercula.

This genus is also closely related to *Spirotropis* and to *Pleurotomoides* (more generally known as *Pleurotomella*). All three are deep-water genera with *Turricula* notches and grade into each other, both in shell characters and opercula. Unfortunately the changes in shell characters do not take place at the same time as the changes in opercula, and classifications must differ according to which criterion they are based on. Since the arrangement of the *Turridæ* by means of opercula has led only to confusion and in details studied closely turns out to be unreliable, shell characters will here be found more useful. The carinated forms of typical *Spirotropis* like *S. polycaste* (Dall) have a shape almost identical with that of *Leucosyrinx* subgenus *Aforia* as represented by *L. kincaidi* Dall, except that they are considerably smaller and have a shorter anterior canal. Some of the species of *Spirotropis* lack opercula; some of the species of *Aforia* have opercula resembling those of the operculate species of *Spirotropis;* some are peculiarly modified. Typical *Pleurotomoides* has shorter, more inflated whorls and is also small, usually with both axial and spiral sculpture as in *Surculina,* and lacks the operculum. It is divided from *Spirotropis* by its sculpture, and from *Leucosyrinx* by its small size, etc.; but the more material is studied the more evident it is that these three genera intergrade and that some of the inoperculate species should be assigned to *Leucosyrinx* and *Spirotropis* as well as to *Pleurotomoides*. Perhaps some small species of *Pleurotomoides* will be found that retain opercula. Von Martens, Thiele, and others have described deep-sea *Turridæ,* as well as Dall; but the present writers have not been able to give the time for a more thorough study of this subject, for these deep-sea species have not yet been reported fossil.

Subgenus **LEUCOSYRINX,** s. s.

Whorls sculptured with fine spiral lines and nodes on the shoulders; operculum with apical nucleus as in *Turris,* but wider and thinner.

The form of the operculum of the type species of this subgenus is not very different from that most common in the *Turridæ,* according to Dall's description. *Aforia* is distinguished as a subgenus by its weaker sculpture. It is doubtful whether any Pacific coast species belongs to this typical subgenus.

Subgenus **AFORIA** Dall, 1889

Aforia Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 18, p. 99, 1889.

Irenosyrinx Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 257, 1908, type (by original designation) *Pleurotoma* (*Leucosyrinx*) *goodei* Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 300, pl. 6, fig. 1, 1889, living, in 1050 fathoms northwest of Patagonia.

Type (by original designation), *Surcula circinata* Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 61, pl. 2, fig. 5, 1873, figure reproduced by Tryon, Man. Conch., Vol. 6, p. 316, pl. 6, fig. 76, 1884; Dall, Bull. 112, U. S. Nat. Mus., p. 68, pl. 11, fig. 6, 1921; + *Pleurotoma insignis* Jeffreys; living Bering sea to Fuca Strait in deep water.

Shell like that of the typical variety, the anterior canal varying in length; whorls with a peripheral shoulder or keel but with only faint spiral sculpture and no nodules; operculum varying in form.

This subgenus is difficult to distinguish from the typical subgenus, with which on the Atlantic coast it seems to intergrade. It is much more characteristic of the Pacific coast, where *Leucosyrinx*, *s. s.*, is only doubtfully represented. Species that the writers believe should be classed here are *Aforia circinata* (Dall), *Leucosyrinx kincaidi* Dall, *Leucosyrinx amycus* Dall, *Irenosyrinx goodei* (Dall), *Leucosyrinx goodei* variety *persimilis* Dall (note that Dall assigns his variety to a different genus),[1] all from the Pacific; and *Leucosyrinx subgrundifera* Dall and *Pleurotomella edgariana* Dall from the Atlantic. *Aforia* is similar to *Surculites* in general form, but can be distinguished by its deeper notch, sometimes remote from the suture, and by its thin shell.

The opercula of this group vary considerably in form. That of *L. goodei* is described by Dall as follows:

> "Operculum at first shaped like that of *Volutopsis*, the nucleus apical but the succeeding growth showing a tendency to a slight spirality; with subsequent growth this becomes inclosed by additions made all around the margin, and the adult operculum appears buccinoid, having a buccinoid outline, in the lower right hand part of which the nuclear part is inclosed. This singular form of operculum is not a deformity, but is common to several of the species of *Leucosyrinx* in which I have been able to examine this appendage. It is a feature which, by gradual stages, represented by different species, approaches the normal Pleurotomoid operculum."

Thus it is evident that we have here a variable character in a single group of species and not a series of fixed characters in several distinct genera. The form of the operculum varies, as Dall points out, from the extreme of *L. goodei* to the more usual Turrid form, represented probably by that of *L. verrillii*. The operculum of *L. circinata* was not discovered until after many specimens had been examined; and because of the artificial custom of classifying by means of the opercula, this species was long thought to be related to *Mangelia*, though it was obviously out of place when associated with that genus. Other groups classified on the basis of opercula appear to be as noticeably out of place, including perhaps *Phymorhynchus* and various species assigned to *Pleurotomella*, if not the whole genus *Pleurotomella* (= *Pleurotomoides*), which is almost surely more closely related to *Leucosyrinx* and *Spirotropis* than it is to *Mangelia*. *Surculina* provides another example of difficulties caused by too much faith in opercula, and many other examples could be given.

Dall stresses a small notch which is sometimes found on the anterior part of the outer lip of *L. circinata* as a reason for separating *Aforia* generically, but he does not explain why this character of unknown meaning should be of so much importance.

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[1] *Leucosyrinx goodei* var. *persimilis* Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 301, pl. 6, fig. 3, 1889, from Chile and Ecuador.
Leucosyrinx persimilis Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 271, pl. 12, fig. 2, 1908; Bull. 112 U. S. Nat. Mus., p. 68, 1921, abyssal, eastern Pacific, with varieties as far north as Washington.

Subgenus **SUAVODRILLIA** Dall, 1918

Suavodrillia Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 331, 1918.

Type (by original designation), *Drillia kennicottii* Dall, described and figured in the Amer. Journ. Conch., Vol. 7, p. 102, pl. 16, fig. 2, 1871, also in Tryon, Man. Conch., Vol. 6, p. 209, pl. 13, fig. 69, 1884, and illustrated in Bull. 112 U. S. Nat. Mus., p. 69, pl. 11, fig. 7, 1921, and in Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 71, pl. 6, fig. 5, 1927; living, Alaska.

Shell like that of *Aforia*, with a somewhat angular notch remote from the suture, but with a shorter anterior canal.

Distribution: Alaska.

It is quite likely that this form is not significantly different from *Aforia*. It resembles in outline *Clavatula coronata* variety *sacerdos* (Reeve), but differs in notch and sculpture.

Subgenus **STEIRAXIS** Dall, 1895

Steiraxis Dall, Proc. U. S. Nat. Mus., Vol. 18, p. 15, 1895; Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 257, 1908.
?? Phymorhynchus Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 258, 1908, type (by original designation) *Pleurotomella* (*Phymorhynchus*) *castanea* Dall, Proc. U. S. Nat. Mus., Vol. 18, p. 15, 1895; Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 284, pl. 1, fig. 1, 1908, deep water in the Gulf of Panama and the Galapagos Islands.

Type (by monotypy), *Pleurotoma* (*Steiraxis*) *aulaca* Dall, Proc. U. S. Nat. Mus., Vol. 18, p. 14, 1895; Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 273, pl. 2, fig. 5, 1908, deep water in the Gulf of Panama and off Acapulco, Mexico.

Shell like that of the typical subgenus but with strong, sharp, spiral cords; operculum with an apical nucleus, somewhat spiral in its growth (sometimes lacking ?).

This subgenus has an operculum which is not so extreme in its form as that of *L. goodei*. Some of the species assigned by Dall to *Phymorhynchus*, including the type, have approximately the same shape and size and sculpture as *Steiraxis;* but they are said to lack opercula, to have an anatomical peculiarity (shared by *P. argeta*, which looks like a *Spergo* or *Eubela*), and the posterior notch appears to be nearer the suture. Hence *Phymorhynchus* may be significantly different. The writers would include *Irenosyrinx crebristriata* Dall, from deep water southwest of Sitka, Alaska, in the subgenus *Steiraxis*.

Subgenus **SURCULINA** Dall, 1908

Surculina Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 260, 1908.

Type (by original designation), *Daphnella* (*Surculina*) *blanda* Dall, *op. cit.*, p. 291, pl. 3, fig. 1, 1908, from deep water in the Gulf of Panama.

Shell like that of the typical subgenus but not quite so large, with a wide anterior canal of variable length, with axial ribs and spiral striations; operculum (always ?) lacking.

As the type of this subgenus was said by Dall to lack the operculum, it was assigned to an inoperculate division of the family far removed from *Leucosyrinx*. However, the form of *blanda* is practically identical with that of a species *galapagana* described by Dall as *Leucosyrinx*, though Dall did not state whether the latter has an operculum or not. The shell characters of *Surculina* ally it to *Leucosyrinx;* and the writers propose that *galapagana* be assigned to *Surculina*, the latter to be used as a subgenus of *Leucosyrinx*. In many respects *Surculina* is closely allied to *Turricula*.

There is a group of deep-water species with high spires and short anterior canals that appears to fall in the middle of the triangle between *Surculina*, *Spirotropis*, and *Pleurotomoides*. It includes the following:

Pleurotomella parella Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 282, pl. 14, fig. 4, 1908, Ecuador.
Leucosyrinx pacifica Dall, *op. cit.*, p. 270, pl. 12, fig. 3, 1908, Alaska.
Pleurotomella pandionis Verrill, illustrated by Dall in Bull. 37 U. S. Nat. Mus., pl. 60, fig. 69, 1889, Rhode Island.
Spirotropis limula von Martens, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 7, p. 61, pl. 5, fig. 23, 1904; Thiele, Vol. 17 p. 222 (188), pl. 37 (25), fig. 4, 1925, New Amsterdam Island, Antarctic.
? Leucosyrinx clionella Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 270, pl. 14, fig. 3, 1908, Gulf of Panama.

These species are too large and high spired for *Pleurotomoides*, too much sculptured for *Spirotropis*, and have too short anterior canals for normal *Leucosyrinx*. For the time being, it would be best to leave them where their authors have placed them, noting that *Pleurotomella* becomes *Pleurotomoides* and that the *Leucosyrinx* species are most like the subgenus *Surculina*.

Genus **PLEUROTOMOIDES** Bronn, 1831

Defrancia Millet, Mém. de la Soc. Linn. de Paris, p. 437, "early in 1827," cited as 1826, the original list including *milleti* Desm., *suturalis* Millet, *pagoda* Millet, probably *hordiacea* Millet, and one other species unknown to the writers, who have not been able to consult this reference; not *Defrancia* Bronn, 1825, genus of Bryozoa according to Carpenter, 1857; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 259, 1908.

Pleurotomoides Bronn, Ital. Tert. Gebilde, p. 47, 1831, name as originally proposed including *Defrancia* Millet, not Bronn, and several species cited as examples, the first of which is *Murex reticulatus* Renier; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 321, 1918, type designated *Defrancia pagoda* Millet.

Lora Gistel, Naturgeschichte des Thierreichs für höhere Schulen, p. ix, 1848, in part only, not the type (see heading for *Lora*).

Clathurella Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 399, 1857, new name as originally proposed including *Defrancia* Millet not Bronn with two additional species, *Clavatula rava* Hinds and *Clathurella aurea* Carpenter, in part only, not the type (see heading for *Clathurella*); Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 259, 1908.

Pleurotomella Verrill, Amer. Journ. Sci., Ser. 3, Vol. 5, p. 15, 1873, type (by monotypy) *Pleurotomella packardii* Verrill, described, *loc. cit.*, figured in Trans. Conn. Acad. Sci., Vol. 5, pl. 42, fig. 9, pl. 57, fig. 5, 1882, figure reproduced by Tryon, Man. Conch., Vol. 6, p. 316, pl. 29, fig. 59, 1884, other figures by Dall, Bull. 37 U. S. Nat. Mus., p. 102, pl. 44, fig. 7, and varieties, pl. 14, fig. 4, pl. 60, figs. 70, 70*a*, 72, 1889, reprinted 1903, type locality St. Georges Bank, Gulf of Maine, 110 fathoms, varieties down to 1507 fathoms; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 18, p. 119, 1889; Vol. 43, p. 258, 1908.

Type (by subsequent designation, Dall, 1908, for *Defrancia* Millet, the first designation of a species from Millet's original list, designation expressly applied in 1908 to *Clathurella*, in 1918 also expressly applied to *Pleurotomoides*, see discussion under *Raphitoma*), *Defrancia pagoda* Millet, Miocene of Europe, figured by Chenu, Man. Conchyl., Vol. 1, p. 148, fig. 656, 1859 (not *Pleurotoma pagodus* Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 27, species 242, 1845, nor *Pleurotoma pagoda* Reeve, *op. cit.*, pl. 37, species 344, corrected to *Pleurotoma turris* Reeve in the index and errata).

Shell small, short, turreted, with axial and spiral sculpture; aperture elongate, narrow, sinuous, outer lip thin, sharp, without denticulations, posterior notch deep, rounded, close to the suture, inner lip smooth, without callus, columella short, twisted, anterior canal short, curving, with a shallow notch behind; operculum (always ?) wanting.

Geologic range: Miocene (of Europe) to Recent, possibly also Eocene, if *Systenope* Cossmann is a subgenus.

Distribution: Deep water off the Atlantic coast.

As the synonymy of this genus indicates, the nomenclature of this and related groups is in a deplorable state of confusion. The recent nomenclature specialists have been inclined to place all the later substitute names proposed for *Defrancia* in synonymy with *Pleurotomoides*, taking *P. pagoda* as the type, and then to shelve *Pleurotomoides* because the type is a fossil. The present identification of *Pleurotomoides* as *Pleurotomella* is based on a study of Chenu's figure of the type of the former and of various figures and specimens of the latter. It is possible that such an identification may be wrong; but the two have been classed in the same group by practically every author, and a comparison of the illustrations of the types shows that they are practically identical in form. The only noticeable difference is that the axial sculpture appears to be stronger in *P. pagoda*, so that the last rib has a varix-like appearance; and Dall mentions in *P. pagoda* a projection of the outer lip between the suture and the posterior notch, though this feature is distinctly omitted in Chenu's figure. Assuming then that *P. pagoda* and *P. packardii* belong to the same group, it is evident that the two species are as close to each other in shape and sculpture as any other really distinct species assigned to either name is to either type, and much closer than most of them. Hence the writers believe that there is less risk of being wrong in calling this group *Pleurotomoides* than there would be in continuing to call it *Pleurotomella*. As the older names must be identified sooner or later, it is desirable to start using them again as soon as an identification of reasonable reliability can be made.

The close relationships between *Leucosyrinx*, its subgenus *Surculina*, and *Pleurotomoides*, and also between these and *Spirotropis*, all typically deep-water genera, is pointed out in the discussions under each heading. *Pleurotomoides* is distinguished by its small size, by its typically short form, by the presence of both axial and spiral sculpture, and by its deep posterior notch. On the other hand, it grades into the typically cold water group here called *Lora*. This latter group, because of its zoological similarity and intergradation with *Pleurotomoides*, has been involved in the same nomenclatorial confusion, and most of the generic names which have been used for *Lora*, including *Lora* itself, have been pronounced invalid. According to the opinion of the present writers, however, *Lora* can be saved and used as Dall used it for the group formerly called *Bela*, *Clathurella*, etc. *Lora* is distinguished from *Pleurotomoides* principally by its shallower notch, which is usually located on the angle and may appear entirely absent, and by its undifferentiated anterior canal, as well as by the lack of an operculum.

Pleurotomoides oceanida (Dall),[1] from deep water in the Gulf of Panama, is a typical *Pleurotomoides*. "*P.*" *herminea* Dall, another Pacific coast species, described and figured in the same place, looks more like a *Spirotropis* (*Typhlomangelia*); and "*P.*" *thalassica* Dall seems from the figure to be specifically the same as "*? Mangilia*" *carlottæ* Dall, which is not a typical species of anything, but may belong in *Lora* in the vicinity of *nunivakensis*. Another species which probably belongs here is *Pleurotomoides eurybia* (Dall),[2] from deep water off Cape San Quintin, Lower California. The same may be true of *Pleurotomoides ? calypso* (Dall),[3] from deep water off San Diego; but this species is not typical, being like *P. gypsina* (Dall), from the Hawaiian Islands, very similar in form to *Hemipleurotoma* except that the posterior notch is above the angle. A specimen in the Oldroyd Collection at Stanford University labeled in Dall's handwriting *Cryptogemma pernodata* is the same as *Pleurotomoides calypso;* hence the names *exuriens* and *pernodatus*, the types of which Dall thought too poor to figure, may be earlier names for the same species, or they may at least be congeneric.

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[1] *Pleurotomella oceanida* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 51, pl. 3, fig. 5, 1919.

[2] *? Mangilia eurybia* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 72, pl. 22, fig. 2, 1919.

[3] *Cryptogemma calypsa* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 31, pl. 9, fig. 8, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 78, pl. 3, fig. 3, 1927.

Genus **LORA** Gistel, 1848

? *Ishnula* Clarke in Gray, Proc. Zool. Soc. London, p. 134, 1847, type (by monotypy) *Mangelia menardiana* Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 222, pl. 9, fig. 130 (explanation of fig., p. 437), 1826, "fossile à la Trinité," which probably means Pliocene of Trinità, southeast of Asti, Italy, near the Miocene contact.

Not *Pleurotomina*, Unknown writer, Deutsche Naturforscher und Aerzte, Amtlicher Bericht über die 24te Versammlung in Kiel in September, 1846, p. 115 (Kiel), 1847 = *Pleurotomina* Gray, Ann. [and Mag.] Nat. Hist., Vol. 1, p. 28, 1838, group name for small Turrids used as follows: "DRILLIA, Gray. (Pleurotomina) Shell turreted . . ." etc.

Lora Gistel, Naturgeschichte des Tierreichs für höhere Schulen, Foreword, p. ix, (Stuttgart) 1848, new name for *Defrancia* Millet and *D. viridula* O. Fabricius; Iredale, Proc. Malac. Soc. London, Vol. 10, p. 225, 1912; Vol. 12, p. 326, 1917; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 318, 328, 1918, type designated *Tritonium viridulum* O. Fabricius; Vol. 56, p. 39, 1919.

Oenopota Mörch, Cat. Conch. Yoldi, p. 73, 1852, list consists of *pleurotomaria* Couth., *pingelii* Beck, *livida* Möll., *viridula* Möll. (non Fabr.), all from Greenland; Iredale, Proc. Malac. Soc. London, Vol. 11, p. 299, 1915; Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 40, 1919, type designated, *Pleurotoma pleurotomaria* Couthouy = *Fusus pleurotomarius* Couthouy, Bost. Journ. Nat. Hist., Vol. 2, p. 107, pl. 1, fig. 9, 1838, deep water, Massachusetts Bay.

"*Bela* Gray," H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 92, 1853, example *Bela turricula* Montagu; name used erroneously in this sense by many authors since 1853; this usage corrected by Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, Australasian, p. 60, 1897; Iredale, Proc. Malac. Soc. London, Vol. 11, p. 297, 1915; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 318, 1918.

Onopota Mörch, H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 654, 1858, = *Oenopota*.

Ischnula Mörch, Vidensk, Meddel. Naturh. Forh. Kjöbenhavn for 1868, p. 214, 1869, species assigned here, *turricula* (with vars. *maxima, nobilis, scalaris, exarata*) and *trevelliana*, *fide* Iredale, Proc. Malac. Soc. London, Vol. 11, p. 300, 1915.

Propebela Iredale, Proc. Malac. Soc. London, Vol. 13, p. 32, 1918, type (by original designation) *Murex turricula* Montagu.

"*Pleurotomina* Beck," Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 330, 1918, "new name for *Defrancia* Millet not Bronn. *Bela impressa* Mörch, sole species," *Pleurotoma* (*Ischnula*) *impressa* Mörch being described in the Mém. Soc. Malac. de Belgique, Vol. 4, p. 21, 1869, *fide* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 40, 1919.

Type (by subsequent designation, Dall, 1918), *Tritonium viridulum* O. Fabricius, 1780, + *Bela exarata* Möller according to the type specimen (*fide* Dall), not *Defrancia viridula* Möller, 1842.

Shell of fairly small size, thin, spire varying from high to short and ovate, whorls turreted, rounded, or only slightly convex, sculptured with axial ribs and spiral striations; aperture about half the length of the shell, ovate, outer lip thin, simple, in the tabulate forms angulated by the tabulation, otherwise smoothly curving, posterior notch in the tabulate forms coinciding with the angle and usually not very evident, but in round-whorled forms often shown plainly in the curving back of the axial ribs and growth lines, inner lip resorbed, columella nearly straight, anterior canal short, broad, only indistinctly defined; operculum (always ?) present.

Geologic range: U. Miocene to Recent.

Distribution: In all Arctic seas and at depth in temperate regions; Antarctic.

The proper name for this genus is still in doubt. The type of *Ishnula* looks very much like a member of this genus, but it comes from a locality in Italy where a cold-water species would not be expected. The character and identity of *Ishnula menardiana* should be determined by duplicating Risso's collection from Trinità. In the meantime *Ishnula* had better be referred to *Mangelia.* Gistel proposed the name *Lora* in these words: "Defrancia (Millet, Gasterop. D. viridula O. Fabr.): Lora, N." So far as the writers could ascertain, Gistel had nothing else to say about the name he was proposing. He did not actually say that *Lora* was a substitute name for *Defrancia* and his signs might be interpreted as indicating that the name *Lora* should cover a group of species in general co-extensive with the group at that time assigned to the discarded name *Defrancia* and including particularly *D. viridula* O. Fabricius, which was then considered a *Defrancia.* Surely the only species definitely cited by Gistel in connection with his new name should be available for type, although the reference to *Defrancia* Millet should also make available all of Millet's five species. A similar interpretation is applied to *Pleurotomoides* Bronn and to other cases where the name proposed is not specifically stated to be a "new name for" an older name believed to be invalid. It is to be noted that Hedley,[1] Woodring,[2] and others have adopted a similar interpretation for *Eucithara* Fischer. Since *Tritonium viridulum* O. Fabricius is the first among the six available species to be definitely cited as the type of *Lora*, it is here considered the type.

"*Pleurotomina* Beck," cited by Dall, was not used in a generic sense in 1847. In a list of Spitzbergen shells sent to a convention of German naturalists and physicians by order of the King of Denmark from the collection of Dr. Kroyer of Copenhagen appears the following expression: "21) Pleurotomina nov. sp. (nahe turric. Mont.) 1 Exempl." According to Dall: "Earlier in the same work the name is cited as of Gray, as if it covered all small Pleurotomids." This earlier occurrence of the word could not be found, but it is quite clear that whoever was the author of the unsigned list used the name in a supergeneric sense as Gray did. It is just as if he had said "21) Turrid, new species allied to *turricula* Montagu, 1 specimen." As pointed out by Dall, the species was not described until 1869; and at that time the name "*Pleurotomina*" was not used. Why Dall should say it was a new name for *Defrancia* Millet not Bronn, it is impossible to explain.

The genus *Pleurotomoides* (+ *Pleurotomella*) is distinguished by its much deeper posterior notch and usually by more inflated whorls and narrower anterior canal. Also, it is inoperculate. Typical *Mangelia* is not difficult to distinguish from *Lora*, being smaller, with simpler sculpture, having a more evident posterior notch, a narrower anterior canal, and often a higher spire; but the subgenus *Bela* has a posterior notch similar to that of *Lora*, and whereas typical *Bela* may be distinguished by its high spire and few blunt ribs, the section *Ishnula* sometimes approaches *Lora* so closely that its lack of operculum must be resorted to to distinguish it. The section *Kurtziella* of *Bela* usually has a higher spire and a smaller shell than *Lora*, but it is sometimes shouldered and has finer axial sculpture and more evident spiral sculpture than is usual in *Mangelia*. The result of these similarities is that some species have apparently been given separate names in both *Lora* and *Mangelia*. *Lora* has a straighter columella and a narrower aperture than *Amphissa* and never has a denticulate outer lip, while the latter is never tabulate.

Lora is a characteristically cold-water genus. Practically all of its species occur in the Arctic and range down the coasts of both the Atlantic and the Pacific, seeking greater depth as they go into warmer latitudes. The little stunted species *brachis* Dall is found in 812 fathoms off the Galapagos Islands, almost on the Equator, where the bottom temperature is practically the same as the deep-water temperatures off Alaska. A similar species, perhaps the same species, *hebes* Verrill, comes from the Atlantic.

The species of *Lora* are so variable that it is very difficult to find any two specimens that look alike, and as a result a multitude of names have been proposed. The different species have each been given several names in the eastern Atlantic, several in the western Atlantic, and several in the Pacific, and many of the distinctions have been made so fine that their own authors fail absolutely in trying to follow them. It is obvious that a drastic consolidation of names must be made, making allowances for a certain amount of variation, before a large number of the existing specimens (representing unnamed intermediate variations) can be identified. It is absolutely unscientific to make no allowances for variation, especially in a group like the one here considered, which is among the most variable.

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[1] Hedley, Rec. Austral. Mus., Vol. 13, p. 260, 1922.

[2] Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 168, 1925.

The outline of species which the present writers offer was unfortunately put together hastily, without due consideration of all the synonymy, so that there are undoubtedly mistakes in it; but it is hoped that by arranging and defining the species already reported, some of them can be correctly identified, whereas hitherto practically all the identifications of specimens (living or fossil) other than the original types have been erroneous, showing that the species have been split below the natural units.

"Lora" grippi Dall is more probably a *Bellaspira.* It is figured in Bull. 112 U. S. Nat. Museum, p. 74, pl. 3, fig. 8, 1921.

A. Turreted Species

Lora viridula (O. Fabricius)

Plate 32, Figures 39, 40, 41

Tritonium viridulum O. Fabricius, Fauna Groenlandica, p. 402, 1780; Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 298, 1886.

? Buccinum viridulum O. Fabricius, Gmelin in Linnæus, Syst. Nat., Ed. 13, p. 3493, 1790.

Defrancia exarata Möller, Index Molluscorum Groenlandiæ, p. 12, 1842.

Not *Defrancia "viridula* Fabricius," Möller, Index Molluscorum Groenlandiæ, p. 14, 1842.

Not *Pleurotoma exarata* Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 23, species 201, 1845, a *Clavus* (*Cymatocyrinx*) sp.

Not *"Pleurotoma viridula* Möller," Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 34, species 306, 1846 = *? Mitrella holbölii* Beck (cf. *M. rosacea* Gould).

Tritonium mitrula Lovén, K. Svensk. Vet.-Acad. (Stockholm), Forh., Vol. 3, p. 85, 1846.

Fusus fidicula Gould, Proc. Bost. Soc. Nat. Hist., Vol. 3, p. 141, 1849; Rept. U. S. Exploring Exped. (Wilkes), Vol. 12, p. 233, 1852, Mollusca Atlas, pl. 16, figs. 284, 284*a*, 284*b*, 1856.

Not *Admete "viridula* O. Fabricius" Sars, Moll. Reg. Arct. Norv., p. 216, pl. 13, fig. 1*a*, 1878; Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 272, 1886; Dautzenberg and Fischer, Rés. Camp. Sci. Albert I, Prince de Monaco, Vol. 37, p. 55 (complete synonymy of this usage), 1912.

Bela exarata Möller, Sars, Moll. Reg. Arct. Norv., p. 232, pl. 16, fig. 18, pl. IX, fig. 1, 1878; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 285, pl. 31, figs. 32, 33, 1915.

Bela mitrula Lovén, Sars, Moll. Reg. Arct. Norv., p. 233, pl. 23, fig. 9, pl. IX, fig. 2, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 29, fig. 51, 1884; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 286, pl. 31, figs. 30, 31, 1915.

Not *Bela viridula* Möller, Sars, Moll. Reg. Arct. Norv., p. 235, pl. 16, figs. 7, 8, pl. IX, fig. 5, 1878, = *Bela kobelti* Verkrüzen.

Bela fidicula Gould, Tryon, Man. Conch., Vol. 6, p. 222, pl. 37, fig. 17, 1884; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 209 in part (probably not pl. 7, fig. 10), 1903.

Not *"Bela fidicula* Gould," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 217, pl. 5, fig. 50, 1909 = *tabulata* Carpenter.

Lora viridula Fabricius, Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 328, 1918; Vol. 56, p. 40, 1919.

? Lora mitrata Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 43, pl. 16, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 119, 1927.

Lora exarata Möller, Dall, Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 101, 1927.

Lora fidicula Gould, Dall, Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 78, pl. 5, fig. 2, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 102, 1927.

Shell of small or moderate size, not heavy, turreted, a little more than half as wide as high; whorls sculptured by about 25 axial riblets almost equal in width to the interspaces, passing from the suture straight across the shelf to the angle where they may be slightly nodulous and then dropping vertically downward until they die out gradually about the middle of the body whorl, axial riblets crossed by numerous weaker spiral cords, angulation varying from a square to a very obtuse angle, usually definite; aperture about half as long as the shell, roughly oval but angulated by the shoulder, outer lip simple, the notch coinciding with the angulation but very obscure, inner lip resorbed, columella nearly straight, slightly whittled off at the base, anterior canal short, wide, shallow, not at all notched behind; animal operculate.

Dimensions: Length, 12 mm.; length of aperture, 6 mm.; diameter of body whorl, 6 mm.

Type specimens: Of *viridula,* location unknown to the writers, but it was examined by Dall; of *exarata,* in Zoology Museum, Christiania (*fide* Oldroyd); of *fidicula,* in the U. S. National Museum; of *mitrata,* No. 87,857 in the U. S. National Museum.

Type localities: Of *viridula* and *exarata*, Greenland; of *fidicula*, Puget Sound; of *mitrata*, Alaska.

Pliocene: England (Harmer).
Pleistocene: England (Harmer); lower San Pedro near San Pedro, Los Angeles Co., California (Arnold).
Living: Circumboreal, south to Norway, Labrador, Alaska, etc., in shallow water; Puget Sound, and from 591 fathoms off Monterey, California.

This species, the type of the genus, is very interesting, particularly because of its wide distribution. The identification of *viridula* (Fabricius) is based principally on Dall, who says that he saw the type. If this identification is incorrect, the species will take the name of *exarata*. As Gould's *fidicula* is practically identical with *exarata*, the well-known Pacific coast name will have to be abandoned. The form *mitrata* Dall is about twice as large as the typical *viridula*, and the angulation is noticeably more obtuse; hence it is possible that *mitrata* should be retained as a variety, or that it may even be more closely related to *tenuilirata cymata* Dall, as suggested by Dall, the last probably being a form of *gigantea* (Mörch). Its size, however, may be due merely to its coming from a more normal, more favorable habitat for the species. *L. mitrula* (Lovén) seems to be another clear synonym of *exarata* and therefore also of *viridula*.

Lora viridula is closely related to several other common species. It is distinguished from *L. turricula* by its smaller and more numerous axial riblets, and, on the whole, by its smaller, more delicate shell; but it goes through a series of variations parallel to those of *turricula*, and the two appear to intergrade intimately enough so that *turricula* and its varieties might be, and have been by a number of workers, considered varieties conspecific with this species. *L. viridula* approaches the form of *L. reticulata* (Brown), but the latter may be distinguished by its weaker sculpture, its narrower and weaker tabulation, and its more evident posterior notch. Varieties of *L. viridula* approach the form of the round-whorled species like *L. declivis*, and it is quite evident that even the most widely different Loras are closely related.

The specimen figured by Arnold from the San Pedro Pleistocene as *fidicula* is more probably a variety of *turricula*, and most of the specimens in the Arnold Collection labeled *fidicula* more closely resemble *L. scalaris* (Möller) (= *turricula*) variety *ecarinata* (Sars), which in turn may be more closely related to *L. declivis* (Lovén); but there are two specimens in the collection from the lower Pleistocene of the San Pedro hills that the writers would class as typical *viridula*. Dall states that Reagan's "*fidicula*," from the upper Miocene of Washington, belongs to his species *miona*, which is a synonym of *tabulata* (Carpenter).

Lora turricula (Montagu)

Plate 32, Figures 42, 43

Murex turricula Montagu, Testacea Britannica, p. 262, pl. 9, fig. 1, 1803.
Murex angulatus Donovan, Nat. Hist. Brit. Shells, Vol. 5, pl. 156, 1803.
Defrancia nobilis Möller, Index Molluscorum Groenlandiæ, p. 12, 1842.
Defrancia scalaris Möller, *op. cit.*, p. 12.
Defrancia woodiana Möller, *op. cit.*, p. 13.
Pleurotoma turricula Montague, Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 19, fig. 162, 1844.
Pleurotoma rugulatus Möller MS., Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 37, fig. 345, 1846.
Mangelia (*Bela*) *turricula* Montagu, Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 450, pl. 111, figs. 7, 8, (in Vol. 4), pl. TT, fig. 2, animal (in Vol. 1), 1853.
? Bela rugulata Möller MS., Troschel, Geb. der Schnecken, Vol. 2, p. 44, pl. 4, fig. 6, 1866; Sars, Moll. Reg. Arct. Norv., p. 230, pl. 23, fig. 6, pl. VIII, fig. 13, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 33, fig. 60, 1884; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. I, p. 282, pl. 31, figs. 5, 11, 12, 1915.

Pleurotoma dowsoni S. V. Wood, Mon. Palæo. Soc., Vol. 25, Mon. Crag. Moll., Suppl. or Vol. 3, p. 39, pl. 3, figs. 13, 14, 1872; not of Harmer, 1915.

Bela nobilis Möller, Sars, Moll. Reg. Arct. Norv., p. 228, pl. 16, figs. 19, 20, pl. VIII, fig. 14, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 28, fig. 44, 1884; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 281, pl. 31, figs. 17-21, 1915.

Bela scalaris Möller, Sars, Moll. Reg. Arct. Norv., p. 229, pl. 23, fig. 5, pl. VIII, fig. 16, 1878; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 278, pl. 31, figs. 1-4, 1915.

Bela assimilis Sars, Moll. Reg. Arct. Norv., p. 231, pl. 23, fig. 8, pl. VIII, fig. 17, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 28, fig. 44, 1884.

"*Bela harpularia* Couthouy," Sars, Moll. Reg. Arct. Norv., p. 150, pl. 16, fig. 17, pl. IX, fig. 3, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 28, fig. 45, 1884.

Bela gouldii Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 465, pl. 57, fig. 6, 6*a*, 1882, new name for *rugulata* Sars not Reeve; Tryon, Man. Conch., Vol. 6, p. 220, pl. 29, fig. 68, 1884.

Bela turricula Montagu, Tryon, Man. Conch., Vol. 6, p. 219, pl. 27, fig. 22, 1884; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 276, pl. 32, figs. 7-11, 1915.

Bela rugulata Troschel var. *spitzbergensis* Friele, Norwegian North Atlantic Expedition, Vol. 3, Pt. 16, p. 3, pl. 7, figs. 3, 4, 1886.

Bela odhneri Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 293, pl. 32, figs. 19, 20, 1915, new name for *Bela assimilis* Sars, 1878, not Wood, 1872.

Bela rugulota Troschel var. "*scalaroides* Sars," Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 283, pl. 31, figs. 13, 14, 1915.

Lora rugulata Troschel, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 50, pl. 13, fig. 6, 1919.

Lora scalaris Möller, Dall, Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 96, pl. 7, fig. 8 (reproduction of Friele's figure), 1927.

Lora nobilis Möller, Dall, Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 109, pl. 7, fig. 9, 1927.

Lora woodiana Möller, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 111, 1927.

Lora turricula Montagu, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 80, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 115, 1927.

Lora rugulata spitzbergensis Friele, Dall, Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 117, pl. 7, fig. 10, 1927.

Shell large for the genus, moderately high spired, turreted; whorls marked by a strong angle above which they are nearly tabulate, sculptured with strong axial ribs, about sixteen to a whorl, which pass vertically from suture to suture, rounding over the angle (or slightly pointed on the angle), but not at all curved by the posterior notch, growing faint only on the base of the body whorl, crossed by numerous spiral striations; aperture half or a very little less than half the length of the shell, ovate with blunted ends, outer lip simple, posterior notch obscure, coinciding with the angle, inner lip resorbed, columella nearly straight, anterior canal short and shallow; operculum with a terminal nucleus, small, not nearly filling the aperture.

Dimensions (of Montagu's figure): Length of shell, 17 mm.; of aperture including canal, 8.5 mm.; diameter of body whorl, 7 mm. Maximum length noted (of *nobilis*), 27 mm.

Type specimens: Of *turricula*, in Museum Macgillivray (*fide* Oldroyd); of the other names, Copenhagen, Christiania, etc. (see Oldroyd).

Type localities: Of *turricula*, Sandwich, Kent; of the other names, Arctic points.

Geologic range: Pliocene to Recent in England and California.

Distribution: Circumboreal, south to Great Britain in the Atlantic and to Puget Sound in the Pacific.

Harmer soundly berates Jeffreys, Tryon, and others for recognizing the variability of this species. It is possible that the present writers have included in the species more than they should have, but it is probable that most of the forms included belong here and a number of others besides. It is interesting to note that Harmer figures almost identical series of specimens as *turricula* and as *rugulata*, and that similar series could be made up from his figures of other "species." The forms *rugulata* (Möller) and *scalaroides* (Sars) differ from each other in shell characters more than do any of the other named forms here classed under *turricula*, yet Harmer keeps them together while at the same time he separates from them specifically other shells that much more closely resemble them. It is true that *rugulata* and *scalaroides* have similar radula teeth (figured by Sars) and that their teeth differ markedly from those of the other forms; but if this classification based on radula teeth is correct, then the details of shell characters (upon which most of the other names are based) mean practically nothing, and there is little justification for using so many names. The writers have not seen any work illustrating or describing the variation of a large series of radula teeth from individuals of one species, and hence cannot form an estimate of the value of this character for classification. As radulæ in fossils cannot be seen and even in living animals are little known, it is evident that shell characters offer a means of classifying species that is much more nearly universal in its adaptability. Hence, in cases of conflict (i. e., in nearly all cases) the evidence from the radulæ should not be used until it can be shown that it is of significance. Species should not be divided up unless the basis for separation is understood, for if the separation is artificial and indefinite there will be more misidentifications than correct identifications, and much labor that might be applied profitably elsewhere will be expended without adding anything to the accuracy of the results. It might be mentioned also that Harmer's "*scalaroides*" is somewhat different from Sars', more closely resembling *rugulata*, but that there is no reason to believe that it had the same kind of teeth, for it is a fossil.

The type specimen of *turricula* is of medium size, has a spire of medium height and a strong tabulation. The species as a whole varies in size, in the number of ribs, in the strength and sharpness of the tabulation, and in the relation of the height of the spire to the length of the aperture. The form *nobilis* differs only in being larger, the form *rugulata* (Troschel) in having a shorter spire, and the form *spitzbergensis* or *gouldii* in having a sharper angle. It is to be noted that Reeve was the first to publish Möller's manuscript name *rugulata* and that his form is somewhat different from that of Troschel and Sars. Harmer's figure 7 of *turricula* has a higher spire than the typical form and might better be referred to the variety *rosea* (Lovén). Arnold's "*Bela fidicula* Gould" may also belong with *rosea*, although it has more sloping shoulders, like the variety *cinerea* (Möller) (= *scalaroides* Sars), and is here assigned to another variety, *schneideri*. The variety *cinerea* has a spire relatively shorter than that of *rosea*, more like that of the typical *turricula* and the form *nobilis*, and the axial ribs are not very strong. Sars' variety *ecarinata* of *scalaris* resembles so much more the round-whorled group that it is here classed with *declivis* (Lovén); but a large number of specimens may show that *ecarinata* was properly placed here by Sars and even that *declivis* also may be a variety of *turricula*.

The species *turricula* as a whole is distinguished from *viridula* by its fewer and usually stronger axial ribs and by its generally heavier shell. From *reticulata* (Brown) it is distinguished by its stronger sculpture and tabulation, by its larger size, and by the fact that the notch is less distinct, the ribs not curving as they pass across the shelf above the angulation. From *impressa* (Beck in Mörch) it is distinguished by its larger size and by its relatively narrower axial ribs.

Variety **turricula**, s. s.

Shell of large or moderate size, with strong sculpture and strong angulation, spire as long as the aperture or only a little longer.

The distribution of this variety is practically the same as that for the species as a whole. There are in the Oldroyd Collection at Stanford University some characteristic specimens that were collected in Puget Sound.

Lora turricula (Montagu) variety **rosea** (M. Sars in Lovén)

Tritonium roseum M. Sars MS. in Lovén, K. Svensk. Vet-Akad. (Stockholm), Forh., Vol. 3, p. 84, 1846.

Pleurotoma turricula var. *rosea* (Sars) Lovén, Jeffreys, Brit. Conch., Vol. 4, p. 396, 1867.

Bela "harpularia" var. *rosea* (M. Sars) Lovén, G. O. Sars, Moll. Reg. Arct. Norv., p. 234, pl. 23, fig. 10, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 28, fig. 37, 1884; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 288, pl. 32, figs. 16, 17, 1915.

Bela turricula rosea Lovén, Kobelt, Icon. Schalentrag. Europ. Meeresconch., Vol. 3, p. 238, pl. 82, fig. 5, 1905.

Lora rosea M. Sars, Dall, Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 120, 1927.

Shell smaller, with a higher spire and a weaker angle than that of the typical variety.
Dimensions: Length, 12 mm.; length of aperture, 5 mm.; diameter of body whorl, 4.5 mm.

Type specimen: In the Museum Christiania (*fide* Oldroyd).

Type locality: Norwegian coast.

M. Pliocene: Coralline Crag, England (Harmer).
U. Pliocene-Pleistocene: Possibly the occurrences of "*Bela fidicula* Gould" Arnold in California (see below).
Recent: Circumboreal, in the Atlantic south along the Norwegian coast to Great Britain (Harmer), in the Pacific south to the northern part of the coast of Washington (Dall).

This variety resembles the form *angulosa* (Sars) of *L. elegans* (Möller), but it can be distinguished by the fact that the ribs pass straight across the shelf above the angulation. The "*Bela fidicula* Gould" of Arnold is very similar to this variety; but it is barely distinguishable by its fewer, coarser spiral lines, and is here tentatively assigned to variety *schneideri* (Harmer).

Lora turricula (Montagu) variety **schneideri** (Harmer)

? "*Bela fidicula* Gould," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 209 in part, pl. 7, fig. 10, 1903.

Bela rugulata Troschel var. *schneideri* Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 284, pl. 31, figs. 15, 16, 1915.

? *Mangilia althorpi* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 68, pl. 19, fig. 9, 1919; Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 135, 1927.

? *Mangilia granitica* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 67, 1919; Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 134, 1927.

Shell like that of variety *rosea*, but with coarser spiral sculpture.
Dimensions: Length, 12-15 mm.; breadth, 5-6 mm.

Type specimens: Of *schneideri*, in the Harmer Collection; of *althorpi* and *granitica*, Nos. 208,560*a* and 208,560, respectively, in the U. S. National Museum.

Type localities: Of *schneideri*, Pliocene of England; of *althorpi* and *granitica*, Granite Cove, Port Althorp, Alaska.

M. Pliocene: Coralline Crag and Red Crag, England (Harmer).
U. Pliocene: Icenian, England (Harmer); ? Santa Barbara, California (Arnold).
L. Pleistocene: ? "Pliocene" and lower San Pedro series at Deadman Island, Los Angeles Co., California (Arnold).
U. Pleistocene: March gravels, England (Harmer); ? Upper San Pedro series at Crawfish George's, Los Angeles Co., California (Arnold).
? Recent: Granite Cove, Port Althorp, Alaska (Dall).

This variety seems to have been more common in the late Pliocene and Pleistocene than it is now; but it is not at all certain that all of Arnold's reports should be credited here. Arnold's figured specimen, which agrees very well with Harmer's fig. 15, came from the lower San Pedro series. Dall's two Mangelias also appear to be very close. As *althorpi* is figured, it will take precedence over its almost certain synonym *granitica*.

Dall did not mention whether he knew these forms to be inoperculate or not; but in any case the similarity between them and Arnold's "*fidicula*" is too evident to be overlooked.

This variety has sparser sculpture than *L. declivis* var. *ecarinata* (Sars), and it has a wider, much more sloping shelf than *L. tabulata* (Carpenter). It also resembles some species of *Mangelia*, like *M. hecetæ* Dall and Bartsch, but it can usually be distinguished from them by its larger size and more numerous, rougher ribs. The attempt has been made to use *rugulata* for the forms with coarser spiral sculpture; but judging by the early figures of *rugulata*, this course is not feasible.

Lora turricula (Montagu) variety **cinerea** (Möller)

Defrancia cinerea Möller, Index Molluscorum Groenlandiæ, p. 13, 1842.

Bela scalaroides Sars, Moll. Reg. Arct. Norv., p. 231, pl. 23, fig. 7, pl. VIII, fig. 15, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 28, fig. 39, 1884.

Bela cinerea Möller, Sars, Moll. Reg. Arct. Norv., p. 227, pl. 23, fig. 4, 1878; Tryon, Man. Conch., Vol. 6, p. 218, pl. 28, fig. 48, 1884.

Shell with a more sloping tabulation and weaker ribs than the typical variety, with a wider body whorl than the variety *rosea*, and finer spiral sculpture than *schneideri*.

Dimensions: Length, 23 mm.; length of aperture, 11 mm.; diameter of body whorl, 9 mm.

Distribution: Finmarck, Lofoten Islands, North Cape, south of Bear Island, Iceland (Harmer); not yet reported in the Pacific.

Harmer's fossils identified as *scalaroides* are here referred to the typical variety of *turricula*. It is to be recalled that this variety, like the form described as *rugulata* Möller by Sars, has unusually stout radula teeth (see the discussion under the typical variety). Sars' illustration of *cinerea* is of a young shell. According to Möller the length would be about 16.5 mm.; Tryon gives it as 22 mm.

Lora turricula (Montagu) variety **popovia** Dall

Lora popovia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 42, pl. 14, fig. 8, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 117, 1927.

Lora kyskana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 47, pl. 14, fig. 3, 1919; Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 77, pl. 18, fig. 2, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 97, pl. 7, fig. 11, pl. 18, fig. 2, 1927.

? Lora fiora Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 302, 1919; Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 103, 1927.

Shell like that of the typical variety but smaller, shorter, with a more obtuse shoulder; spiral sculpture of fewer incised lines with wider interspaces.

Dimensions: Altitude, 13 mm.; length of aperture, 6 mm.; diameter of body whorl, 5.5 mm.

Type specimens: Of *popovia*, No. 220,883, of *kyskana*, No. 224,286, of *fiora*, No. 220,399*a*, in the U. S. National Museum.

Type localities: Of *popovia*, Bristol Bay, Bering Sea; of *kyskana*, Kyska Island, Alaska; of *fiora*, Adakh Island, Aleutians.

Distribution: Alaska to Point Pinos, middle California.

This variety has not yet been reported fossil. It somewhat resembles the variety *schneideri*, having spiral sculpture intermediate between the spiral sculpture of that variety and of the typical variety; but it has a shorter spire and narrower interspaces between the axial ribs. It is very similar in shape and size to Sars' figure of *rugulata*, noted under the typical variety. Young specimens of typical *turricula*, or the early whorls of old specimens, sometimes have this form.

Lora turricula (Montagu) variety **pribilova** Dall

Lora pribilova Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 44, pl. 16, fig. 3, 1919; Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 81, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 98, 1927.

Shell like that of the typical variety but smaller, with a sloping shelf above the angle, but the angle sharply defined.

Dimensions: Altitude, 12 mm.; length of aperture, 6 mm.; diameter of body whorl, 5.5 mm.

Type specimen: No. 225,573 in the U. S. National Museum.

Type locality: Cape Lisburne, Arctic Ocean.

Distribution: Cape Lisburne to Esteros Bay, middle California.

This variety recalls Sars' figure of *assimilis*, listed under the typical variety. The slightly more numerous ribs on the next to the last whorl give it somewhat the appearance of *viridula*.

Lora tabulata (Carpenter)

Mangelia tabulata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 628, 658, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 114, 144 (bottom pagination), 1872.

"*? Mangelia*" *tabulata* Carpenter, Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 29, 1865, reprinted in Smithsonian Misc. Coll., No. 252, pt. E, p. 242 (bottom pagination), 1872.

"*Bela fidicula* Gould," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 209 in part, not pl. 7, fig. 10, 1903; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 217, pl. 5, fig. 50, Nov. 24, 1909, = *miona* Dall, *fide* Dall, 1922.

Mangilia tabulata Carpenter, Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 7, pl. 57, fig. 4, 1907, fig. reprinted in Bull. 321 U. S. Geol. Survey, pl. 11, fig. 4, 1907.

Turris (*Bela*) *tabulata* Carpenter, Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 243, pl. 39, fig. 1, 1918.

"*Mangilia angulata* Carpenter," Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 244, pl. 39, figs. 10*a*, 10*b*, 1918.

Lora tabulata Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 45, pl. 14, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 78, pl. 18, fig. 5, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 101, pl. 7, fig. 13, pl. 18, fig. 5, 1927.

Lora miona Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 47, pl. 14, fig. 2, 1919; Bull. 112 U. S. Nat. Mus., p. 74, 1921; Amer. Journ. Sci., Ser. 5, Vol. 4, p. 312, 1922; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 79, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 102, 1927.

Shell of small or medium size, heavy for its size, with a tall spire; whorls with nearly vertical sides and a strong, rounded angulation, above which is a narrow, almost horizontal shelf; sculpture of about 15 strong axial riblets about as wide as the interspaces, vertical on the sides of the whorls and not curving on the shoulder, crossed by a few coarse spiral cords which become nodulous at the intersections; aperture less than half as long as the shell, bluntly oval, outer lip fairly thick, modified by the shoulder of the body whorl, the very obscure notch situated on the angulation, inner lip resorbed, columella straight, blunt, sometimes with a pseudo-fold or thickening, anterior canal not defined.

Dimensions: Altitude, 11 mm.; length of aperture, 4.5 mm.; diameter of body whorl, 5.5 mm.

Type specimens: Of *tabulata*, in the U. S. National Museum; of *miona*, No. 252,208 in the U. S. National Museum.

Type localities: Of *tabulata*, Vancouver district; of *miona*, Boca de Quadra, Alaska.

U. Miocene: "Quillayute Pliocene" of Washington (Reagan) = the Empire formation of Oregon, according to Arnold and Hannibal; specimen identified by Dall.

U. Pliocene: Santa Barbara (Arnold, 1907).

? Pliocene-Pleistocene: Some of Arnold's records of "*Bela fidicula* Gould" may belong here (see notes on *Lora turricula* var. *schneideri*); some of Harmer's figures of English forms suggest relationships.

Living: Alaska to Monterey, California (Dall).

This species is most closely related to *Lora turricula*, especially to the variety *schneideri* of Harmer, having the notch on the shoulder and the ribs on the shelf not curving back from the angle. Except for the coarse spirals of this species, some of Harmer's illustrations of typical *turricula* might be taken for it. On the other hand, *turricula* usually has a broader shelf, a better defined anterior canal, and not such a short aperture. The ribs on *turricula* variety *schneideri* have much wider interspaces.

Probably most of the reports of "*Bela fidicula* Gould" from the Tertiary and Quaternary of California are to be assigned to this species.

Lora impressa (Beck in Mörch)

Pleurotoma (*Bela*) *impressa* Beck, Mörch, "Cat. Moll. Spitzb.," Mém. Soc. Malac. Belg., Vol. 4, p. 21, 1869.

Pleurotoma novaja-semljensis Leche, Kongliga Svenska Vetenskaps-Akademien (Stockholm), Handlinger, Ny Följd., Vol. 16, pp. 2, 53, pl. 1, fig. 15, 1878.

Pleurotoma impressa Beck, Leche, Kongliga Svenska Vetenskaps-Akademien (Stockholm), Handlinger, Ny Följd., Vol. 16, p. 54, pl. 1, fig. 16, 1878.

"*Bela cancellata* Migh.," Sars, Moll. Reg. Arct. Norv., p. 224, pl. 23, fig. 3, pl. VIII, fig. 9, 1878.

Bela sarsii Verrill, Proc. U. S. Nat. Mus., Vol. 3, p. 364, 1880; Tryon, Man. Conch., Vol. 6, p. 218, pl. 28, fig. 49, 1884; Friele, Norwegian North Atlantic Exped., Vol. 3, Pt. 16, p. 18, pl. 8, figs. 3, 4, 5, pl. 10, figs. 7, 8, 1886; Dautzenberg and Fischer, Rés. Camp. Sci. Albert 1, Prince de Monaco, Vol. 37, p. 48, 1912.

? *Bela concinnula* Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 468, pl. 43, fig. 15, pl. 57, fig. 11, 1882; Tryon, Man. Conch., Vol. 6, p. 220, pl. 29, fig. 54, 1884.

Bela novaja-semljensis Leche, Tryon, Man. Conch., Vol. 6, p. 215, pl. 33, fig. 63, 1884.

Bela impressa Beck, Tryon, Man. Conch., Vol. 6, p. 220, pl. 33, fig. 69, 1884; Friele, Norwegian North Atlantic Exped., Vol. 3, Pt. 16, p. 18, pl. 8, figs. 1, 2, pl. 10, fig. 9, 1886; Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 278, 1886.

?? *Lora amiata* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 303, 1919; Bull. 112, U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 115, 1927.

Lora impressa Mörch, Dall, Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 95, 1927.

Lora novaiasemliensis Leche, Dall, Bull. 112, U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 111, 1927.

Shell of medium size, spire of medium height or short, turreted; whorls with a fairly strong tabulation, the shelf above the angle with very weak or no sculpture, the lower part of the whorl sculptured with about 20 narrow, vertical axial grooves between which are broad flat-topped ridges crossed by similar, somewhat weaker spiral grooves; aperture about half as long as the shell, blunt-ovate, outer lip curving, the posterior notch broad and shallow, filling the posterior end of the aperture, columella nearly straight, sliced off at the end, anterior canal short.

Dimensions: Altitude, 15 mm.; length of aperture, 8 mm.; diameter of body whorl, 8 mm.

Type specimens: Of *impressa*, at Copenhagen (*fide* Oldroyd); of *sarsii*, at Christiania ?; of *novaja-semljensis*, in the Academy of St. Petersburg ? (*fide* Oldroyd); of *amiata*, No. 214,219 in the U. S. National Museum.

Type localities: Of *impressa*, Spitzbergen; of *sarsii*, Norwegian coast; of *novaja-semljensis*, Nova Zembla; of *concinnula*, New England; of *amiata*, Belkoffski, Alaska.

Distribution: Circumboreal, south to New England in the Atlantic, and along the Alaskan coast in the Pacific.

This species is characterized by its broad, flat-topped ribs and spiral grooves, which give it a tuberculated appearance. It is distinguished from *excurvata* (Carpenter) by its broader, more sloping shoulder.

Lora elegans (Möller)

Defrancia elegans Möller, Index Molluscorum Groenlandiæ, p. 13, 1842.

Bela elegans Möller, Sars, Moll. Reg. Arct. Norv., p. 225, pl. 16, fig. 15, pl. VIII, fig. 12, 1878; Tryon, Man. Conch., Vol. 6, p. 218, pl. 29, fig. 53, 1884.

Bela obliqua Sars, Moll. Reg. Arct. Norv., p. 226, pl. 16, fig. 6, pl. VIII, fig. 11, 1878; Tryon, Man. Conch., Vol. 6, p. 219, pl. 28, fig. 50, 1884.

Bela angulosa Sars, Moll. Reg. Arct. Norv., p. 227, pl. 16, fig. 16, pl. VIII, fig. 10, 1878; Tryon, Man. Conch., Vol. 6, p. 218, pl. 28, fig. 46, 1884.

Lora inequita Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 44, pl. 16, fig. 9, 1919; Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 96, 1927.

Lora monterealis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 46, pl. 15, fig. 9, 1919; Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 114, 1927.

Lora sixta Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 49, pl. 16, fig. 12, 1919; Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 104, 1927.

Lora galgana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 303, 1919; Bull. 112, U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 105, 1927.

? Lora babylonia Dall, Proc. Biol. Soc. Wash., Vol. 32, p. 250, 1919; Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 99, 1927.

Lora elegans Möller, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 111, 1927.

Shell of medium size, with a rather high spire, whorls moderately shouldered, sculptured with 14-18 axial riblets, narrow and distant on the early whorls but sometimes flattening out on the body whorl, strongly curved backwards when they pass over the sloping shelf but making a broad, smooth arc, convex anteriorly, over the whole width of the body whorl below the shoulder, crossed by moderately strong spirals, sometimes of unequal prominence; aperture less than half the length of the shell, bluntly ovate, outer lip thin, smoothly curving except where it is indented by the posterior notch between the suture and the angulation, inner lip resorbed, columella nearly straight, anterior canal usually not well defined, short and broad.

Dimensions: Altitude, 15 mm.; length of aperture, 6.5 mm.; diameter of body whorl, 6 mm.

Type specimens: Of *elegans*, in Zoölogy Museum, Copenhagen (*fide* Oldroyd); of *inequita*, No. 222,238, of *monterealis*, No. 226,160, of *sixta*, No. 209,235, of *galgana*, No. 214,173, of *babylonia*, No. 214,192, in the U. S. National Museum.

Type localities: Of *elegans*, *obliqua*, and *angulosa*, along the Norwegian coast ?; of *inequita*, Plover Bay, Bering Sea; of *monterealis*, deep water off Monterey Bay, California; of *sixta*, deep water off San Diego, California; of *babylonia*, off Tillamook Bay, Oregon, in deep water.

Distribution: Circumboreal, southward along the Norwegian coast in the Atlantic, and in the Pacific to San Diego in deep water.

This species is distinguished from *viridula*, *turricula*, and others, by the position of the notch as indicated by the curvature of the axial ribs, from *reticulata* (Brown) by its less numerous axial ribs, and from *harpularia* (Couthouy) by its more distinct angulation, higher spire, etc. The form *angulosa* might be retained as a variety with narrower, more elongate body whorl, corresponding to the variety *rosea* of *turricula*. The form *obliqua* is characterized by radula teeth with more elongate bases; but as explained above, the writers do not know if this character is of any significance. The form *babylonia* might be retained as a variety with a keel.

Lora reticulata (Brown)

Pleurotoma reticulata Brown, Ill. Rec. Conch. Gt. Brit. and Ire., Ed. 1, pl. 48, figs. 29, 30, 1827; Ed. 2, p. 8, pl. 5, figs. 29, 30, 1844.

Pleurotoma trevellianum Turton, [Ann. and] Mag. Nat. Hist., Vol. 7, p. 351, 1834.

Pleurotoma "decussata Brown," Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 19, fig. 159, 1844 (Brown's *Fusus decussatus* belongs to the *Muricidæ*).

Pleurotoma leucostoma Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 31, species 278, 1845.

Mangelia (*Bela*) *trevelliana* Turton, Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 452, pl. 112, figs. 1, 2 (in Vol. 4), 1853.

Pleurotoma trevelyana Turton, Jeffreys, Brit. Conch., Vol. 4, p. 398, 1867, Vol. 5, p. 222, pl. 91, fig. 8, 1869.

Pleurotoma (*Ischnula*) *trevylliana* Turton, Mörch (various catalogues), 1868, 1869, etc.

Bela trevelyana Turton, Sars, Moll. Reg. Arct. Norv., p. 235, pl. 16, fig. 13, pl. IX, fig. 4, 1878; Tryon, Man. Conch., Vol. 6, p. 221, pl. 27, fig. 29, pl. 33, fig. 65, 1884; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 294, pl. 32, figs. 30-33, 1915.

Bela reticulata Brown, Dautzenberg and Fischer, Rés. Camp. Sci. Albert I, Prince de Monaco, Vol. 37, p. 46 (full synonymy), 1912.

Lora surana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 45, pl. 14, fig. 6, 1919; Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 114, 1927.

Lora colpoica Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 50, pl. 16, fig. 2, 1919; Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 104, 1927.

Lora pitysa Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 40, pl. 16, fig. 7, 1919; Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 98, 1927.

Lora diegensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 46, pl. 16, fig. 10, 1919; Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 114, 1927.

Lora trevelliana Turton, Dall, Bull. 112 U. S. Nat. Mus., p. 78, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 123, 1927.

Shell of small size, rather short; whorls not very strongly shouldered, sculptured with numerous fine axial ribs dying out about the middle of the body whorl of adults, and numerous fine spirals; aperture about half the length of the shell, blunt-ovate, outer lip bulging in the middle, the notch occurring above the shoulder and causing the axial ribs to bend as in *elegans* and *harpularia*, inner lip resorbed, columella almost straight, anterior canal hardly defined, very short.

Dimensions: Altitude, 10 mm.; length of aperture, 5 mm.; diameter of body whorl, 4.5 mm.

Type specimens: Of *reticulata*, in Edinburgh ?; of *trevelliana*, in the British Museum (*fide* Oldroyd): of *leucostoma*, in the British Museum (?); of *surana*, No. 206,590, of *colpoica*, No. 214,193, of *pitysa*, No. 209,851, of *diegensis*, No. 209,421*a*, in the U. S. National Museum.

Type localities: Of *reticulata*, Greenock, Scotland; of *trevelliana*, Scarborough, England (*fide* Oldroyd); of *leucostoma*, Greenland; of *surana*, Point Sur, California; of *colpoica*, Tillamook, Oregon; of *pitysa*, Point Pinos, California; of *diegensis*, San Diego, California.

M. Pliocene-Pleistocene: England (Harmer).

Living: Circumboreal, in the Atlantic south to Great Britain and Massachusetts, in the Pacific to San Diego.

This species is distinguished by its moderate angulation, its fine sculpture, small size, short spire, and its posterior notch, which is above the angle and is more evident than in the *turricula* group. The form *diegensis* and its synonym *pitysa* are smaller, young, or underdeveloped. They may be of varietal significance. The best illustration of typical *reticulata* is given by Reeve as "*decussata*" from Aberdeen.

Lora reticulata (Brown) variety **metschigmensis** (Krause)

Bela metschigmensis Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 276, pl. 18, figs. 2, 10, 1886.

Lora metschigmensis Krause, Dall, Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 110, pl. 11, fig. 13, 1927.

Shell short, turreted; whorls with nearly vertical sides and a narrow, nearly horizontal shelf behind the angle, sculptured with about 24 vertical axial ribs, which begin with little nodes on the angle but die out on the lower part of the body whorl, shelf sculptured only by five crowded spiral threads; aperture a little more than half as long as the shell, ovate, anterior canal undefined.

Dimensions: Altitude, 11 mm.; length of aperture, 6 mm.; diameter of body whorl, 5.4 mm.

Type specimen: In the Stuttgart Royal Cabinet (*fide* Oldroyd).

Type locality: Metschigme Bay, Bering Strait.

This variety is very similar to the typical form, but is distinguished by its lower spire and its more distinct, more nearly vertical ribs. It is distinguished from *impressa* by its narrower ribs and undefined anterior canal. It is not so short as *hebes* and *brachis*.

Lora hebes (Verrill)

Bela hebes Verrill, Proc. U. S. Nat. Mus., Vol. 3, p. 367, 1880; Trans. Conn. Acad. Sci., Vol. 5, p. 459, pl. 57, fig. 7, 1882; Tryon, Man. Conch., Vol. 6, p. 217, pl. 29, fig. 69, 1884.

Compare *Lora brachis* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 41, pl. 7, fig. 3, 1919.

Shell small, very short, turreted; whorls sculptured with numerous spirals and irregular growth lines; aperture short, broadly ovate, inner lip strongly concave, end of the columella sliced off diagonally.

Dimensions: Altitude, 8 mm.; length of aperture, 5 mm.; diameter of body whorl, 5 mm.

Type locality: Of *hebes*, off Newport, Rhode Island, in deep water.

This little species is interesting because of its extremely short shape, and because forms with this shape appear both in the Atlantic and the Pacific in deep water in the southerly part of the range of the genus. *Lora brachis* comes from deep water off the Galapagos Islands, almost on the Equator. *L. brachis* would be practically indistinguishable from *hebes* if it were not for its somewhat better defined axial riblets, about 30 to the whorl, sloping as in the form *surana* of *Lora reticulata.*

This species is very similar to the type of *Gymnobela* Verrill,[1] which is distinguished chiefly by its lack of an operculum. The writers are inclined to consider this criterion of little importance.

Lora harpularia (Couthouy)

Fusus harpularius Couthouy, Bost. Journ. Nat. Hist., Vol. 2, p. 106, pl. 1, fig. 10, 1838.

Pleurotoma decussata Couthouy, Bost. Journ. Nat. Hist., Vol. 2, p. 183, fifth plate (numbered 4), fig. 8, 1839, not *Pleurotoma decussata* Lamarck, Ann. Mus. Hist. Nat., Vol. 3, p. 267, 1804, nor *Pleurotoma "decussata* Brown" of Macgillivray and of Reeve.

Not "*Bela harpularia* Couthouy," Sars, Moll. Reg. Arct. Norv., p. 234, pl. 16, fig. 17, 1878, = *turricula.*

Bela harpularia Couthouy, Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 473, pl. 43, fig. 14, pl. 57, fig. 9, 1882; Tryon, Man. Conch., Vol. 6, p. 219, pl. 29, fig. 51, 1884.

? "*Bela decussata* Couthouy," Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 479, pl. 43, fig. 13, 1882; Tryon, Man. Conch., Vol. 6, p. 217 in part, pl. 29, fig. 55, etc., 1884.

? "*Bela plicifera* Wood," Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 300, pl. 32, fig. 28, 1915.

Lora pavlova Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 43, fig. 9, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 115, 1927.

? *Lora casentina* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 302, 1919; Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 105, 1927.

? *Lora rassina* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 303, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 117, 1927.

Lora harpularia Couthouy, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 78, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 112, 1927.

Shell of medium size, spire rather short; whorls obscurely angulated, sculptured with about 20 curving axial ribs, interspaces crossed by numerous fine spiral lines; aperture about half the length of the shell, elongate-ovate, outer lip simple with the notch on or above the obscure angle, inner lip resorbed, columella nearly straight, anterior end obliquely cut off, anterior canal short but defined.

Dimensions: Altitude, 13 mm.; length of aperture, 7 mm.; diameter of body whorl, 6 mm.

Type specimens: Of *harpularia*, in the collection of the Boston Society of Natural History; of *pavlova*, No. 226,200, of *cassentina*, No. 209,257, of *rassina*, No. 214,224, in the U. S. National Museum.

Type localities: Of *harpularia*, near Swampscott on the north shore of Massachusetts Bay; of *pavlova*, Pribilof Islands, Bering Sea; of *casentina*, Monterey Bay, California; of *rassina*, Bristol Bay, Bering Sea.

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[1] *Gymnobela* Verrill, Trans. Conn. Acad. Sci., Vol. 6, p. 157, 1884, original list includes two new species, *engonia* and *curta*, the latter figured; type designated by Cossmann, Ess. Paléo. Comp., Vol. 2, p. 63, 1896, *G. engonia* Verrill.

Distribution: Circumboreal, in the Atlantic south to Long Island, in the Pacific south to Monterey, California.

This species is distinguished from *reticulata* by its fewer, more distant ribs, from *pyramidalis* by its weaker ribs and shorter spire, from *turricula* var. *popovia* (young) by its curving ribs, and from *excurvata* (Carpenter) by its curving ribs and its more excavated shelf. The true form of *decussata* Couthouy not Lamarck has a higher, more rounding shoulder somewhat like that of *solida* (Dall). It is probable that this species occurs fossil both on the Atlantic and Pacific shores, but none of the records can be relied upon.

Lora solida (Dall)

Bela solida Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 301, pl. 3, fig. 4, 1886.
Lora solida Dall, Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 81, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 116, 1927.

Shell fairly small, short; whorls with a high, rounded shoulder, over which pass about 13 strong, high, rounded ribs with narrower interspaces, the ribs bent backward on the shoulder, ribs and interspaces crossed by fine spiral striations; aperture about three-fifths the length of the shell, elongate, blunt-ovate, columella straight, anterior canal short, hardly defined.

Dimensions: Altitude, 13 mm.; length of aperture, 8 mm.; diameter of body whorl, 7 mm.

Type specimen: In the U. S. National Museum.

Type locality: Kyska, Alaska.

Distribution: Bering Sea to Puget Sound.

This stumpy little species recalls *quadra*, but the shoulder is much higher and larger and the ribs fewer and stronger.

B. Species with High Spires and Non-Tabulate Whorls

Lora alitakensis Dall

"*Bela cancellata* Mighels," Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 475, pl. 43, figs. 10, 11, pl. 57, fig. 13, 1882; Tryon, Mau. Conch., Vol. 6, p. 218, pl. 29, fig. 67, 1884.
Lora alitakensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 43, pl. 15, fig. 7, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 116, 1927.

Shell of medium or large size, with a moderately high spire, round-whorled, fusiform; sculptured by about 14 strong, fold-like axial ribs which pass from suture to suture but are strongly curved on the upper part of each whorl and become obsolete on the lower part of the body whorl, axial ribs and interspaces crossed by irregularly distributed spiral grooves with broad, nearly flat, raised interspaces; aperture varying in length from about half as long as the shell to noticeably less, ovate, outer lip smoothly curving, with a broad retraction to represent the posterior notch at the point of greatest convexity of the whorl, inner lip resorbed, columella nearly straight, long, anterior canal defined, but short and fairly broad.

Dimensions: Altitude, 20 mm.; length of aperture, 10 mm.; diameter of body whorl, 9 mm.

Type specimen: No. 222,088 in the U. S. National Museum.

Type locality: Unimak Island, Aleutians.

Distribution: Alaska to Labrador and Martha's Vineyard.

This species is most closely related to *pyramidalis*, from which it is distinguished by its stronger, more fold-like ribs, its broader spiral bands, and its longer aperture. Verrill's "*cancellata*" has much more prominent axial sculpture and a different shape from that indicated in the original description and illustration of *cancellata*. A peculiar form that should perhaps be known as *Lora lyciaca* (Forbes in Reeve)[1] resembles somewhat this species; but its whorls are more turreted as in *turricula*, and its columella is longer. Tryon points out that it is a young shell, and as it is said to come from Asia Minor, it is doubtful whether it is a *Lora* at all.

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[1] *Pleurotoma lyciaca* Forbes, Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 19, species 160, January, 1844.
Bela lyciaca Forbes, Tryon, Man. Conch., Vol. 6, p. 221, pl. 27, fig. 28, 1884.

Lora levidensis (Carpenter)

Mangelia levidensis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 603, 658, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 89, 144, 1872; Proc. Acad. Nat. Sci. Phila., p. 63, 1865; Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 299, 1886.

Mangelia funebrale Dall, Amer. Journ. Conch., Vol. 7, p. 100, 1871.

Mangilia (*Clathromangilia*) *levidensis* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 62, pl. 21, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 82, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 86, pl. 5, fig. 3, pl. 45, fig. 4, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 144, pl. 2, fig. 21, 1927.

Shell of medium or large size, spire moderately high; whorls rounded, with a very slight rounded shoulder, sculptured with about 12 broad, rounded axial ribs running vertically from suture to suture, spiral sculpture of strong, high cords with equal interspaces, crossing the ribs as well as the interspaces, about 20 on the body whorl, 5 or 6 showing on the penultimate whorl; aperture a little less than half the length of the shell, blunt-ovate, outer lip simple, with practically no notch, anterior canal short and broad, poorly defined; operculum with a terminal nucleus.

Dimensions: Altitude, 21 mm.; length of aperture, 9 mm.; diameter of body whorl, 8 mm.

Type specimens: In the U. S. National Museum.

Type localities: Of *levidensis*, Vancouver district; of *funebralis*, Sitka, Alaska.

Living: Bering Strait to Monterey, California (Dall).

Dall recognized the synonymy given above. Like the other "Mangelias" reported from Alaska, this species has all the characters of *Lora*, and the writers were inclined to change it to the genus *Lora* even before they found an operculum on one of the specimens in the Oldroyd Collection at Stanford University. This species resembles *Moniliopsis grippi*, but is somewhat smaller and lacks the anal fasciole and the posterior row of nodes of the latter.

Lora alaskensis (Dall)

Mangelia ? alaskensis Dall, Amer. Journ. Conch., Vol. 7, p. 98, 1871.

Bela alaskensis Dall, Tryon, Man. Conch., Vol. 6, p. 216, pl. 34, fig. 5, 1884; ? Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 279, pl. 18, figs. 5, 17, 1886; Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 299, pl. 4, fig. 3, 1886.

? *Mangilia eriopis* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 67, pl. 23, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 82, pl. 19, fig. 3, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 134, 1927.

Lora alaskensis Dall, Bull. 112 U. S. Nat. Mus., p. 78, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 81, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 122, 1927.

? "*Lora rosea* Sars," Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 80, pl. 5, fig. 1, 1924.

Shell of medium or large size, spire high; whorls with a blunt angulation near the top, sculpture very variable, typically with about ten strong, rounded axial ribs running somewhat obliquely downward from the angulation, crossed by many fine spiral lines, other variations, however, with the axial ribs very weak, and possibly still others with fewer, stronger spirals; aperture about two-fifths the length of the shell, ovate, outer lip simple, notch shown to be present by the waving of the growth lines above the angulation but not apparent on the type specimen, anterior canal short, wide; operculum ?.

Dimensions: Altitude, 20 mm.; length of aperture, 8.5 mm.; diameter of body whorl, 8 mm.

Type specimens: In the U. S. National Museum, that of *eriopis*, No. 216,411.

Type localities: Of *alaskensis*, Unga Island, Alaska; of *eriopis*, Forrester Island, Alaska.

Distribution: Bering Sea to Puget Sound.

This species appears to be very variable. The form figured by Krause and acknowledged by Dall as conspecific is almost smooth. *L. aleutica* and *L. sculpturata* are probably varieties. These forms are too big and coarse for *Mangelia;* and although they are not typical *Lora,* they should at least be classed together, and one of them is said to be operculate. The ribs are more oblique and the angulation stronger than on *Mangelia variegata.*

Lora aleutica (Dall)

Mangelia aleutica Dall, Amer. Journ. Conch., Vol. 7, p. 99, 1871.
Bela aleutica Dall, Tryon, Man. Conch., Vol. 6, p. 216, pl. 34, fig. 4, 1884.
Mangilia ? aleutica Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 299, pl. 3, fig. 6, 1886.
Mangilia aleutica Dall, Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 82, pl. 19, fig. 1, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 132, 1927.

Shell like that of *alaskensis,* but specimens of the same size having fewer whorls and a longer columella and anterior canal.

Dimensions: Altitude, 17 mm.; length of aperture, including anterior canal, 8 mm.; diameter of body whorl, 7 mm.

Type specimen: In the U. S. National Museum.

Type locality: The same as that of *alaskensis.*

Distribution: The same as that of *alaskensis.*

This form is probably the young of unusually large individuals of *alaskensis.*

Lora sculpturata (Dall)

Bela sculpturata Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 299, pl. 4, fig. 7, 1886.
Not "*Mangilia sculpturata* Dall," Arnold and others (see *M. roperi*).
Mangilia sculpturata Dall, Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 82, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 135, 1927.

Shell like that of *alaskensis* but with only a few coarse spiral grooves, which nodulate the ribs; operculate.

Dimensions: Altitude, 12.3 mm.; length of aperture, 5.5 mm.; diameter of body whorl, 4.5 mm.

Type specimen: In the U. S. National Museum.

Type locality: Aleutian Islands.

Distribution: Chiachi Islands, Aleutian region, to Port Etches, Alaska; in the original description referred also to the Vancouver district.

This species was described as a *Bela* with an operculum, but was later assigned to *Mangelia.* Perhaps it was found that the operculum did not belong to it. In any case, however, the general appearance, the Alaskan range, and the apparent relationship with *alaskensis* would indicate that it is better placed in *Lora.* It may be only a more coarsely sculptured variety of *alaskensis.*

Lora nunivakensis (Dall)

Mangilia nunivakensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 65, pl. 1, fig. 2, 1919; Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 133, 1927.
? "*Mangilia painei* Arnold," Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 65, pl. 23, fig. 3, 1919.

Shell of medium size, thin, high-spired; whorls rounded, sculptured with 12-18 rounded, curving axial riblets, smooth or crossed on the early whorls by a few sparse spiral striations; aperture less than half the length of the shell, lenticular, outer lip simple, curving back smoothly to a shallow, rounded posterior notch, columella slightly flexuous, anterior canal not defined; (operculum ?).

Dimensions: Altitude, 18 mm.; length of aperture, 8 mm.; diameter of body whorl, 6 mm.

Type specimen: No. 220,348 in the U. S. National Museum.

Type locality: Nunivak Island, Bering Sea.

Distribution: Bering Sea (to San Pedro in deep water ??).

This species is higher spired and has more curving ribs than *harpa*. Its ribs are more numerous than those of *alaskensis*, and the whorls are not angulated. It is placed in *Lora* because of its northern range and its relationship with *alaskensis*, mentioned by Dall. Whatever Dall's "*painei*" is, it is not what Arnold described, or at least not unless *painei* is a species of very unusual variability. It might be a large *Mangelia hecetæ* without the angulation.

Lora pyramidalis (Ström)

Plate 32, Figures 36, 37, 38

Buccinum pyramidale Ström, K. Dansk. Vid. Selsk. Skrift., Vol. 3, p. 297, fig. 22, 1788.
Fusus pleurotomarius Couthouy, Bost. Journ. Nat. Hist., Vol. 2, p. 107, pl. 1, fig. 9, 1838.
Bela pyramidalis Ström, Sars, Moll. Reg. Arct. Norv., p. 222, pl. 16, fig. 3, pl. VIII, fig. 8, 1878; Tryon, Man. Conch., Vol. 6, p. 215, pl. 28, figs. 40, 47, pl. 34, fig. 81, 1884; not Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 295, pl. 28, fig. 1, pl. 32, figs. 1, 2, 1915.
Bela pleurotomaria Couthouy, Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 478, 1882.
Compare *Lora halitropa* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 40, pl. 16, fig. 6, 1919 (young).
Lora pleurotomaria Couthouy, Dall, Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 78, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 100, 1927.

Shell of medium size, high spired; whorls rather strongly rounded, not angulated, sculptured normally with 13-16 strong, curving axial ribs, though on some of the varieties the ribs become weak or obsolete on the body whorl or even on the whole shell, ribs crossed by numerous fine spiral threads usually visible only in the interspaces; aperture less than half the length of the shell, ovate, outer lip thin, the posterior part strongly bent back to form a broad, shallow notch behind the point of greatest curvature of the whorl, inner lip resorbed, columella nearly straight, sometimes slightly curved to the left at its extremity to parallel the outer lip, anterior canal fairly well defined, short, comparatively narrow.

Dimensions (of largest specimen in the Oldroyd Collection at Stanford University): Altitude, 23 mm.; length of aperture, 9 mm.; diameter of body whorl, 8 mm. Other specimens are somewhat less elongate.

Type specimens: Of *pleurotomaria*, in the collection of the Boston Society of Natural History; of *halitropa*, No. 96,216 in the U. S. National Museum.

Type localities: Of *pleurotomaria*, deep water in Massachusetts Bay; of *halitropa*, Magellan Strait, South America.

Distribution: Circumboreal, in the Atlantic south to Cape Cod, in the Pacific south to Puget Sound.

As the original description of this species is inaccessible to the writers, the present identification is made on the basis of Sars' figure. *L. halitropa* is listed above merely to call attention to the fact that the South American form is very similar and is probably related to this group or to the *alaskensis* group. The north Pacific specimens agree very well with the descriptions of *pleurotomaria* by Couthouy and Verrill, and the writers could find nothing of significance to distinguish them from Sars' *pyramidalis*. The forms figured by Harmer as *pyramidalis* have fewer ribs and the ribs do not appear to curve at all, some of the figures looking more like species of *Mangelia*, so that it is doubtful whether they can be conspecific with *pyramidalis* as here understood. The species varies considerably in the relative height of spire, in the number and strength of the axial ribs, and even a little in the number and strength of the spiral lines. The variety *semiplicata* Sars (*op. cit.*, p. 222, pl. 16, fig. 4) almost entirely lacks the ribs on the body whorl. *L. vahlii* (Beck in Möller) is generally assigned here.

L. pyramidalis differs from *pingelii* (Beck in Möller) in its stronger, less numerous axial ribs and its finer spiral sculpture. It differs from *declivis* (Lovén) in its stronger, less numerous, more curving axial ribs, in the less swollen aspect of the whorls, and in the shorter aperture with a better defined anterior canal. It differs from *alitakensis* Dall in having the whorls evenly rounded, the spiral sculpture finer, the axial sculpture much less prominent, and the aperture shorter. The species that Harmer figures may be *alaskensis* (Dall), which has fewer, straighter ribs.

Lora pingelii (Beck in Möller)

Fusus cancellatus Mighels and C. B. Adams, Bost. Journ. Nat. Hist., Vol. 4, p. 52, pl. 4, fig. 18, January, 1842, not *Fusus cancellatus* Sowerby, Min. Conch. Gt. Brit., Vol. 6, p. 45, pl. 525, fig. 2, 1826.

Defrancia pingelii Beck, Möller, Index Molluscorum Groenlandiæ, p. 13, 1842.

Bela pingelii Beck, Sars, Moll. Reg. Arct. Norv., p. 223, pl. 16, fig. 5, 1878; Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 464, pl. 43, fig. 16, 1882; Tryon, Man. Conch., Vol. 6, p. 217, pl. 29, fig. 64, 1884.

Bela conoidea Sars, Moll. Reg. Arct. Norv., p. 236, pl. 16, fig. 14, 1878; Tryon, Man. Conch., Vol. 6, p. 221, pl. 29, fig. 61, 1884.

Shell much like that of *pyramidalis* but with more numerous, finer axial riblets and somewhat coarser spiral lines, so that the two kinds of sculpture are about equal in strength and give the shell a cancellate appearance; outer lip thin, slightly crenulated by the spiral sculpture.

Dimensions: Altitude, 16 mm.; length of aperture, 6.5 mm.; diameter of body whorl, 6 mm.

Type specimen: Of *pingelii,* in the Copenhagen Museum.

Type localities: Of *pingelii,* Greenland; of *conoidea,* Norway.

Distribution: Norway, Greenland, Maine, Cape Cod.

The original figure of *cancellatus* is not very good, apparently causing Sars, Verrill, and Tryon to misidentify it; but as the name is preoccupied, it need no longer be considered. For Sars' *cancellata* see *impressa;* for Verrill's see *alitakensis* Dall. This species is very closely related to *pyramidalis* and should perhaps be considered a variety of it.

Lora declivis (Lovén)

Tritonium declive Lovén, "Index Molluscorum Litora Scandinaviæ Occidentalia Habitantium," K. Svensk. Vet.-Akad. (Stockholm), Förh., Vol. 3, p. 13 (of separate ?), 1846.

Bela declivis Lovén, var., Sars, Moll. Reg. Arct. Norv., p. 224, pl. 16, fig. 10, 1878; Tryon, Man. Conch., Vol. 6, p. 218, pl. 28, fig. 38, 1884.

Lora chiachiana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 43, pl. 14, fig. 7, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 119, 1927.

Shell of medium size, with a moderately high spire; whorls rounded, swollen at the sutures, sculptured with about 16 rather coarse axial riblets which pass from suture to suture almost vertically, with but a very slight curve at the point of greatest convexity of the whorl, ribs crossed by fine spiral lines chiefly visible in the interspaces; aperture nearly half the length of the shell, ovate, outer lip smoothly rounded, with but a very little flexure to represent the posterior notch.

Variety **declivis**, s. s.

Columella nearly straight, with a somewhat prolonged, swollen appearance, anterior canal short, wide, not defined.

Dimensions: Altitude, 20 mm.; length of aperture, 9 mm.; diameter of body whorl, 7 mm.

Type specimens: Of *declivis,* at Stockholm (?); of *chiachiana,* No. 206,207 in the U. S. National Museum.

Type localities: Of *declivis,* Finmarck (?); of *chiachiana,* Chiachi Islands, Aleutian chain.

Distribution: Circumboreal, Norway and Alaska.

This form is closely allied to *pyramidalis* and *pingelii,* from which it is distinguished by its straighter ribs and longer aperture; but it is quite distinct from practically everything else. Sars mentions having seen the type specimen. Dall's *chiachiana* is practically identical with Sars' *declivis* (according to the figures), except that it is slightly shorter and the interspaces between the ribs are narrower. "*Bela dowsoni* S. V. Wood" Harmer[1] is similar, but has fewer, coarser ribs.

Lora declivis (Lovén) variety **ecarinata** (Sars)

Cf. Plate 25, Figure 20

Bela scalaris Möller var. *ecarinata* Sars, Moll. Reg. Arct. Norv., p. 229, pl. 16, fig. 9, 1878.

? Mangilia oldroydi Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 213, pl. 6, fig. 16, 1903; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, 1916; Dall, Bull. 112 U. S. Nat. Mus., p. 80, 1921.

Shell like that of the typical variety but more delicate, with the end of the columella obliquely sliced off parallel to the outer lip, forming an anterior canal.

Dimensions: Altitude, 20 mm.; length of aperture, 9.5 mm.; diameter of body whorl, 8 mm.

Type specimens: Of *ecarinata,* at Christiania ?; of *oldroydi,* No. 429 in the Stanford University type collection.

Type localities: Of *ecarinata,* coast of Norway; of *oldroydi,* lower San Pedro Pleistocene of Deadman Island, Los Angeles County, California.

U. Pliocene: Fourth and Broadway, Los Angeles (Moody).
Pleistocene: Type locality of *oldroydi,* one specimen only.
Living: Type locality of *ecarinata.*

The type of *oldroydi* was recognized by the writers at Stanford and was placed by them in the type collection. It is practically certain that it is a *Lora,* not a *Mangelia;* and it resembles very closely Sars' figure of *ecarinata.* It is, however, about 4 mm. smaller, has a slightly longer aperture (relatively), and the early whorls show traces of an angulation. The spiral sculpture is finer than is indicated in Arnold's figure.

The writers feel hesitant about classifying the variety *ecarinata* with *declivis* in contradiction to Sars, who obviously knew much more about the variations and interrelations of these species. Nevertheless, to all appearances it is much closer to the forms of the high-spired, round-whorled group like *pyramidalis, pingelii,* or *declivis* than it is to the strongly turreted species; and in the present classification, which must be regarded merely as an experimental attempt to arrange the species so that the differences between them can be understood and identifications made with all the forms in mind, the writers have had to depend to a large extent on appearances, even at the risk of being sometimes wrong. If such dissimilar forms as *scalaris* and *ecarinata* are conspecific, then the distinctions that the present writers have attempted to draw, and much more the finer distinctions that other writers have tried to follow, are to be considered of doubtful value.

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[1] "*Bela dowsoni* S. V. Wood" Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 291, pl. 32, fig. 18, 1915.

Lora subluta (Gould)

Fusus sublutus Gould, Proc. Bost. Soc. Nat. Hist., Vol. 3, p. 142, May, 1849; U. S. Exploring Exped. (Wilkes), Vol. 12, p. 235, 1852, Mollusca Atlas, pl. 16, figs. 286, 286*a*, 1856.
Pleurotoma cunninghami Smith, Proc. Zool. Soc. London, p. 27, pl. 4, fig. 1, 1881.
Bela subluta Gould, Tryon, Man. Conch., Vol. 6, p. 222, pl. 32, fig. 18, pl. 34, fig. 75, 1884.
Lora equatorialis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 44, pl. 13, fig. 2, 1919.

Shell of medium size, spire fairly high; whorls strongly rounded, sculptured with about 14 narrow, distant ribs passing nearly vertically over the whorls and crossed by fine spiral lines; aperture about two-fifths the length of the shell, nearly round, posterior notch nearly obsolete, faintly showing at the point of greatest convexity of the whorl as a backward flexure of the lip and ribs, columella gently curved, anterior canal rather narrow for the genus, slightly notched.

Dimensions: Altitude, 13.5 mm.; length of aperture, 5.5 mm.; diameter of body whorl, 6 mm.

Type specimens: Of *subluta*, in the U. S. National Museum (?); of *equatorialis*, No. 97,092 in the U. S. National Museum.

Type locality: Of *cunninghami*, Patagonia.

Distribution: Ecuador to Patagonia.

This very distinct species of the southern hemisphere is included to show the synonymy.

Lora harpa (Dall)

Bela harpa Dall, Proc. U. S. Nat. Mus., Vol. 7, p. 523, 1884; Vol. 9, p. 300, pl. 4, fig. 2, 1886.
"*Bela borealis* Reeve," Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 298, pl. 32, figs. 12, 13, 1915.
Lora harpa Dall, Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 80, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 106, 1927.
Lora skullcliffensis Meek, Univ. Calif. Publ. Geol., Vol. 14, p. 417, pl. 79, figs. 2*a*, 2*b*, 1923.

Shell of medium size, spire moderately elevated; whorls rounded, inflated, sculptured with about 23 axial riblets about equal in width to the interspaces, running nearly vertically from suture to suture, with practically no posterior flexure, crossed by spiral threads; aperture ovate, elongate, a little more than half the length of the shell, outer lip regularly arcuate, with practically no posterior notch, anterior canal short, wide, hardly defined.

Dimensions: Altitude, 17 mm.; length of aperture, 10 mm.; diameter of body whorl, 8 mm.

Type specimens: Of *harpa*, No. 40,959 in the U. S. National Museum; of *skullcliffensis*, No. 30,594 at the University of California.

Type localities: Of *harpa*, Pt. Franklin, Arctic Ocean; of *skullcliffensis*, Pleistocene of Skull Cliff, Peard Bay, northern Alaska.

Pliocene: Iceland; England (Harmer).
Pleistocene: Peard Bay, northern Alaska (Meek).
Living: Circumboreal, Greenland to the Queen Charlotte Islands, British Columbia.

This species has the shape of *Lora simplex*, but is distinguished by the presence of the axial ribs. It is higher spired than *L. kobelti* (= *arctica*), but not so high spired as *L. schmidti*. If Dall's form *cymata* (= *kobelti*) is a variety of *tenuilirata*, then *harpa* may be a variety of *simplex*.

C. OVATE SPECIES, MOSTLY WITH LOW OR WEAK RIBS

Lora sanctæ-monicæ (Arnold)

Bela sanctæ-monicæ Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 210, pl. 8, fig. 14, 1903; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 239, 255, 1916; Moody, Vol. 10, p. 43, 1916.
Lora sancta-monicæ Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921.

Shell of small or moderate size, rather short and rotund; whorls slightly angular above, with about 16 prominent rounded ribs which extend from suture to suture in nearly a straight line, ribs crossed by numerous faint spiral striations; aperture about half as long as the shell, ovate, outer lip smoothly rounded, no notch visible in Arnold's illustration, anterior canal short but defined.

Dimensions (from Arnold): Altitude, 12 mm.; length of aperture, 6.8 mm.; diameter of body whorl, 7.5 mm.; but Arnold's illustration measures: altitude, 12 mm.; length of aperture 6 mm.; diameter of body whorl, 6.5 mm.

Type specimen: No. 162,551 in the U. S. National Museum.

Type locality: "Lower San Pedro series (Pleistocene) at Port Los Angeles, near Santa Monica," Los Angeles Co., California.

M. Pliocene: Wildcat formation, northern California (Martin).
U. Pliocene: Fourth and Broadway, Los Angeles (Moody).
Pleistocene: Of the type locality and of Deadman Island, San Pedro, Los Angeles Co.

This species is distinguished from *arctica* by its fewer and stronger axial riblets. It also resembles in a general way the variety *popovia* of *turricula*, but can be distinguished from that by its greater relative breadth and its weaker angulation. Specimens of *Mangelia* (*Bela*) *hecetæ* are sometimes mistaken for it.

Lora excurvata (Carpenter)

Bela excurvata Carpenter, Brit. Assn. Adv. Sci., Report for 1863, pp. 603, 658, 683, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 89, 144, 169 (bottom pagination), 1872; Proc. Acad. Nat. Sci. Phila., p. 63, 1865.

Bela incisula Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 461, pl. 43, fig. 12, pl. 57, fig. 14, 1882; Tryon, Man. Conch., Vol. 6, p. 217, pl. 29, fig. 65, 1884.

Lora excurvata Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 46, pl. 14, fig. 5, 1919; Bull. 112 U. S. Nat. Mus., p. 78, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 123, 1927.

Lora incisula Verrill, Dall, Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 108, 1927.

Shell small, ovate; whorls somewhat flattened, rounding suddenly over a narrow shoulder into the posterior suture, sculptured with 18 to 20 broad, rounded, nearly straight, very slightly oblique axial ribs which are strongest at the shoulder but die out rather quickly below it, the ribs crossed by spiral grooves which sometimes give them a slightly nodulous aspect, above the shoulder ribs replaced by strongly curving growth lines; aperture about half as long as the shell, elongate-ovate, the outer lip somewhat angulated and strongly notched at the top, anterior canal short, of medium width, poorly defined.

Dimensions: Altitude, 7.2 mm.; length of aperture, 4 mm.; diameter of body whorl, 3.6 mm.

Type specimen: Of *excurvata*, in the U. S. National Museum or in the Academy of Natural Sciences, Philadelphia.

Type localities: Of *excurvata*, Puget Sound; of *incisula*, Labrador (*fide* Oldroyd).

Distribution: Circumboreal, New England to Puget Sound.

Now that Dall has illustrated an authentic specimen of *excurvata*, the synonymy of *incisula* is evident. This species is distinguished from *schantarica* by its shoulder and well-developed posterior notch. It is distinguished from *harpularia* by its straighter, stronger ribs.

Lora quadra Dall

Lora quadra Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 46, pl. 15, fig. 2, 1919; Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 77, pl. 18, fig. 6, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 97, pl. 7, fig. 12, pl. 18, fig. 6, (reproductions of Dall's figure) 1927.

Shell small, short, ovate; whorls rotund, sculptured with about 18 fairly strong, distant axial ribs, nearly straight except at the very top of the whorl where they are abruptly flexed as they pass over a very narrow shoulder; aperture a little more than half as long as the shell, ovate, with a fairly well formed posterior notch, anterior canal not defined, short.

Dimensions: Altitude, 8 mm.; length of aperture, 5 mm.; diameter of body whorl, 5 mm.

Type specimen: No. 223,606*a* in the U. S. National Museum.

Type locality: Unalaska, Aleutian Islands (*fide* Oldroyd).

Distribution: Alaska to Puget Sound.

This form is probably a variety of *excurvata*, but is shorter and has narrower ribs.

Lora schantarica (Middendorff)

Pleurotoma sehantaricum Middendorff, "Beiträge zu einer Malacozoologia Rossica," Mém. Acad. Imp. Sci. St. Pétersbourg, Ser. 6, Vol. 6, Pt. 2, p. ?, 1849; Reise in dem äussersten Norden und Osten Sibiriens, etc., Vol. 2, Pt. 1, p. 223, pl. 12, figs. 17, 19, 1851.

Bela schantarica Middendorff, Tryon, Man. Conch., Vol. 6, p. 214 in part, pl. 34, fig. 76 (reproduction of one of the original figures), 1884.

Shell small, ovate, whorls moderately convex, curving in strongly at the very top toward the suture, sculptured with about 16 nearly straight, broad, rounded ribs separated by shallow, narrow grooves; aperture about half as long as the shell, ovate, posterior notch practically obsolete, anterior canal short.

Dimensions: Altitude, 12 mm.; length of aperture, 6 mm.; diameter of body whorl, 6 mm.

Type specimen: In the Academy of St. Petersburg (probably).

This species bears one of the oldest names, and its identity must be established before we can reach a stable nomenclature. Apparently it was well described and figured by its author, but Middendorff's works have not been accessible to the present writers.

This species is distinguished from *harpularia, excurvata, inflata,* etc., by its lack of a posterior notch, and from *tenuilirata* by its peculiar ribbing. The ribbing resembles more closely that of "*albrechti* Krause" Dall, here doubtfully referred to *lütkeana* Krause (which may have different ribbing—narrower ribs and wider interspaces ?); but Dall's "*albrechti*" has a much shorter aperture.

Lora arctica (A. Adams)

Plate 32, Figures 44, 45

"*Defrancia viridula* O. Fabricius," Möller, Index Molluscorum Groenlandiæ, p. 14, 1842.

Bela arctica A. Adams, Proc. Zool. Soc. London, p. 121, 1855.

Bela kobelti Verkrüzen, Nachrichtsblatt der Deutschen Malakozoologischen Gesellschaft, Jahr. 8, p. 17, 1876; Jahrbuch der Deutschen Malakozoologischen Gesellschaft, Jahr. 3, pl. 4, fig. 5, 1876; Tryon, Man. Conch., Vol. 6, p. 217, pl. 30, fig. 94, 1884.

"*Bela viridula* Möller," Sars, Moll. Reg. Arct. Norv., p. 235, pl. 16, figs. 7, 8, pl. IX, fig. 5, 1878.

Lora tenuilirata cymata Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 42, pl. 16, fig. 4, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 118, 1927.

Lora arctica A. Adams, Dall, Bull. 112 U. S. Nat. Mus., p. 78, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 284, 1927.

Shell of moderate or large size, rather short and rotund; early whorls somewhat angulated, but the body whorl of the adult regularly rounding, sculptured with 20 or more indistinct axial riblets crossed by numerous small spiral grooves, the axial riblets passing almost vertically from suture to suture but curving slightly on the body whorl and dying out below; aperture about half as long as the shell, ovate, outer lip regularly arcuate, apparently without a posterior notch, anterior canal short but defined.

Dimensions (of a small specimen, from Sars): Altitude, 12 mm.; length of aperture, 6.5 mm.; diameter of body whorl, 6 mm.

Type specimens: Of *arctica*, in the Museum Cuming (*fide* Oldroyd); of *cymata*, No. 226,186 in the U. S. National Museum.

Type localities: Of *arctica*, "Arctic seas;" of "*viridula* Möller" Sars, Greenland; of *kobelti*, Newfoundland (?); of *cymata*, Nunivak Island, Bering Sea.

Distribution: Norway, Greenland, Newfoundland (?), Alaska.

Dall's form differs from *kobelti*, which is best described and illustrated by Sars (as *viridula*), only in being about twice as large. The form *kobelti* and perhaps *arctica* itself seem to be young or stunted forms, whereas *cymata* is the normal adult. Dall does not mention how strong the ribs of *cymata* are; but as he considers it a variety of a species without ribs, it is assumed that they are weak. The species apparently thrives better in Alaska than in the Atlantic. It is very much like *L. sanctæ-monicæ* Arnold; and the latter, although it has fewer and much stronger ribs, might possibly be a variety of it. Arnold's type has one less whorl than Dall's; and if the body whorl were removed from the type of *cymata*, the remaining whorls would be very much like *sanctæ-monicæ* in size, shape, and perhaps in sculpture. It is surprising that Dall should put this ribbed form as a variety of *tenuilirata*, but this case is just another rather disconcerting indication that varietal extremes may appear quite different and yet be closely related. It is possible that this species is the same as *schantarica*.

Lora inflata (Posselt)

? Pleurotoma decussata Couthouy, 1839, not Lamarck, 1804, (see *harpularia*).

"*Bela simplex* Middendorff," Jeffreys in Lamplugh, Quart. Journ. Geol. Soc., Vol. 40, p. 320, 1894.

Bela decussata var. *inflata* Posselt, Meddelelser om Grönland, Vol. 23, p. 154, pl. 1, fig. 4 (Kjöbenhavn) 1898; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 289, pl. 31, fig. 27, 1915.

Bela decussata Couthouy, Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 289, pl. 31, figs. 24-26, 1915.

Lora lawrenciana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 43, pl. 15, fig. 6, 1919, new name for "*Bela tenuilirata* Dall," Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 274, pl. 18, fig. 8, 1886; Bull. 112 U. S. Nat. Mus., p. 78, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 124, 1927.

Lora nazanensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 45, pl. 15, fig. 8, 1919; Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 112, 1927.

Shell of small or moderate size, ovate; whorls moderately rounded but with the sutures not deep and each whorl joining the previous whorl at the periphery so that the upper parts of all the whorls unite to form a short conical spire; sculptured with strongly curving, shallow axial grooves, rather distant on the body whorl where they leave between them broad, flat interspaces, but closer together on the early whorls where the interspaces appear as low, rounded ribs, axial sculpture crossed by fainter spiral grooves; aperture nearly two-thirds as long as the shell, broadly lenticular, outer lip curving backwards to a broad, fairly deep posterior notch, anterior canal short and broad, usually not defined.

Dimensions (average form): Altitude, 10 mm.; length of aperture, 6 mm.; diameter of body whorl, 5.5 mm.

Type specimens: Of *lawrenciana*, in the Stuttgart Royal Cabinet (*fide* Oldroyd); of *nazanensis*, No. 220,327 in the U. S. National Museum.

Type localities: Of *inflata*, Greenland; of *lawrenciana*, Plover Bay, Alaska; of *nazanensis*, Nazan Bay, Atka Island, Aleutian Chain.

Pliocene and *Pleistocene:* Of England (Harmer).

Living: Circumboreal; in the Atlantic, Norway, Greenland; in the Pacific, Alaska; more southerly reports on both coasts uncertain.

This ovate species with weak sculpture and well-developed posterior notch is quite distinctive. It is distinguished from *harpa* by its posterior notch; but it is possible that Harmer's variety "*conoidea* Sars" should be referred to *harpa*. The typical *inflata* is the short extreme, and *nazanensis* is the long extreme; but the intermediate forms are common and it seems undesirable to separate them.

Lora lævigata (Dall)

Bela ? lævigata Dall, Amer. Journ. Conch., p. 98, pl. 16, fig. 7, 1871.

Bela gigas Beck MSS. in Verkrüzen, Jahrbuch der Deutschen Malakozoologischen Gesellschaft, Vol. 2, p. 239, pl. 8, figs. 6, 7, 1875; Tryon, Man. Conch., Vol. 6, p. 214, pl. 30, fig. 97, 1884.

"*Bela simplex* Middendorff," Sars, Moll. Reg. Arct. Norv., p. 239 in part, pl. 17, fig. 4, pl. IX, fig. 9, 1878.

Pleurotoma violacea Mighels and Adams variety *mörchi* Leche, K. Svenska Vetenskaps-Akademien (Stockholm), Handl., New Series, Vol. 16, no. 2, p. 57, pl. 1, fig. 18, 1878.

Bela mörchi Leche, Tryon, Man. Conch., Vol. 6, p. 214, pl. 33, fig. 70, 1884.

Bela lævigata Dall, Tryon, Man. Conch., Vol. 6, p. 214, pl. 30, fig. 96, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 300, pl. 3, fig. 7, 1886.

Lora mörchi Leche, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 112, 1927.

Lora lævigata Dall, Bull. 112 U. S. Nat. Mus., p. 78, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 121, 1927.

Shell of small or medium size, low-spired, beet-shaped; whorls rounded, sculptured only by fine spiral lines and lines of growth; aperture varying from two-thirds to three-fourths the length of the shell, ovate, outer lip broadly expanded, posterior notch shallow or entirely obsolete, anterior canal not defined; operculate.

Dimensions (of small specimen): Altitude, 8 mm.; length of aperture, 6 mm.; diameter of body whorl, 5 mm.

Type specimen: Of *lævigata,* in the U. S. National Museum.

Type localities: Of *lævigata,* Norton Sound, Alaska; of *gigas* and *mörchi,* northern Norway ?.

Distribution: Circumboreal, Norway to Alaska (and other places ?).

This species is characterized by its nearly smooth, rounded whorls, by its weak posterior notch, and by its very short spire. Tryon thought this species might be the same as *schantarica,* and it is quite possible that he was right. However, the figure of *schantarica* reproduced by Tryon seems to show axial ribs. This matter is worthy of investigation.

Variety **lævigata,** s. s.

Spire very short, aperture about three-quarters the length of the entire shell, sculpture very weak.

Dall's original specimen was small, but specimens of the other forms listed in the synonymy that are of about the same size commonly occur.

The largest specimen reported is 20 mm. in length.

Lora lævigata (Dall) variety **tenuilirata** (Dall)

Bela ? lævigata variety *tenuilirata* Dall, Amer. Journ. Conch., Vol. 7, p. 98, 1871.

"*Bela simplex* Middendorff," Sars, Moll. Reg. Arct. Norv., p. 239 in part, pl. 23, fig. 11, 1878; Verrill, Proc. U. S. Nat. Mus., Vol. 3, p. 367, 1880.

Bela tenuilirata Dall, Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 463, 1882.

Bela murdochiana Dall, Proc. U. S. Nat. Mus., Vol. 7, p. 524, pl. 2, fig. 8, 1884; Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 275, pl. 18, fig. 9, 1886.

Lora tenuilirata Dall, Proc. U. S. Nat. Mus., Vol. 59, p. 42, pl. 15, fig. 4, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 118, 1927.

Lora murdochiana Dall, Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 119, 1927.

Shell like that of the typical variety but larger, with the convex whorls of the spire standing up a little higher, and with somewhat stronger sculpture, the aperture about two-thirds as long as the shell.

Dimensions: Altitude, 22 mm.; length of aperture, 14 mm.; diameter of body whorl, 12 mm.

Type specimens: Of *tenuilirata*, No. ?, of *murdochiana*, No. 40,960, in the U. S. National Museum.

Type localities: Of *tenuilirata*, Norton Sound, Alaska; of *murdochiana*, Cape Smythe, Arctic.

Distribution: Circumboreal; in the Atlantic south to Norway and to Rhode Island; in the Pacific, Alaska.

This variety is similar to *arctica*, a synonym of which Dall described as a variety of *tenuilirata;* but *arctica* can be distinguished by its axial ribs. The true *simplex* has a more elongate spire and smoother whorls.

Lora healyi Dall

Lora healyi Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 42, pl. 16, fig. 8, 1919; Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 118, 1927.

Shell of medium size, spire moderately elevated; whorls very rotund, sculptured with rather irregular, coarse spiral cords, wider than the interspaces, 6-7 on the penultimate whorl, about 14 on the last whorl, growth lines much weaker; aperture about half as long as the shell, broadly lenticular, posterior notch obsolete, anterior canal not defined.

Dimensions: Altitude, 15 mm.; length of aperture, 7.5 mm.; diameter of body whorl, 7 mm.

Type specimen: No. 223,908 in the U. S. National Museum.

Type locality: North of Bering Strait. Not known elsewhere.

This form is distinguished by its strongly rounded whorls and coarse spiral sculpture. It is very much like *lævigata* variety *tenuilirata*, but has stronger spiral sculpture and a higher spire. It may be another variety of the same species, *tenuilirata* being the normal form.

Lora simplex (Middendorff)

Pleurotoma simplex Middendorff, "Beiträge zu einer Malacozoologia Rossica," separate from the Mém. Acad. Imp. Sci. St.-Pétersbourg, Ser. 6, Vol. 6, Pt. 2, p. 119, 1849; Reise in dem äussersten Norden und Osten Sibiriens, etc., Vol. 2, Pt. 1, p. 223, pl. 12, figs. 15, 16, 1851 (Date according to the Catalogue of the Natural History Books in the Library of the British Museum).

Pleurotoma (*Bela*) *violacea* Mighels and Adams var. *gigantea* Mörch, Ann. Soc. Malac. Belg., Vol. 4, p. 22, 1869.

Pleurotoma violacea var. *gigantea* Mörch, Leche, K. Svensk. Vet.-Akad. (Stockholm), Handl., New Series, Vol. 16, p. 57, pl. 1, fig. 19, 1878.

Bela simplex Middendorff, Tryon, Man. Conch., Vol. 6, p. 214, pl. 29, fig. 56 (one of the original figures reproduced), 1884.

Bela gigantea Mörch, Knipowitsch, Ann. Acad. St. Petersbourg, Vol. 6, p. 482, 1901; Dautzenberg and Fischer, Rés. Camp. Sci., Albert 1, Prince de Monaco, Vol. 37, p. 43, pl. 1, figs. 1, 2, 1912; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 291, pl. 32, fig. 24, 1915.

Lora simplex Middendorff, Dall, Bull. 112 U. S. Nat. Mus., p. 77, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 120, 1927.

Shell large, elongate; whorls not very convex, nearly smooth, with only the faintest growth lines and spiral striations showing; aperture a little more than half as long as the shell, symmetrically ovate, posterior notch practically obsolete, anterior canal very short; operculum with a terminal nucleus, blunt.

Dimensions: Altitude, 20 mm.; length of aperture, 11 mm.; diameter of body whorl, 9.5 mm.

Type specimen: Of *simplex*, in the Academy of St. Petersburg (*fide* Oldroyd).

Type locality: Okhotsk Sea.

Pliocene: Of England (Harmer).

Recent: Circumboreal; in the Atlantic south to Ireland and to the Gulf of St. Lawrence; in the Pacific to the Okhotsk Sea and the Pribilof Islands.

This tall, smooth species resembles a young *Buccinum*. It is more elongate, with less inflated whorls, and has less sculpture than *arctica* or *tenuilirata*. It is larger and higher spired than *lævigata*. The figures by Dautzenberg and Fischer are excellent. The "*simplex*" of Sars and Verrill are referred to *lævigata* and to *lævigata* variety *tenuilirata*.

Lora americana (Packard)

Bela americana Packard, Mem. Bost. Soc. Nat. Hist., Vol. 1, p. 285, pl. 7, fig. 11, 1866; Tryon, Man. Conch., Vol. 6, p. 220 in part, pl. 33, fig. 64, 1884.

Verrill[1] says this species is the largest *Bela* in New England, the name *americana* being a synonym of *scalaris* Möller, and the species often being confounded with *turricula*. However, if Tryon's reproduction of Packard's figure correctly represents Packard's type, the identifications of Verrill and other Atlantic coast conchologists are all erroneous. The figure shows a shell without angulation, with the whorls shaped and sculptured somewhat like the whorls in the figure of *schantarica*, but with a higher spire and a longer columella and anterior canal. It looks like *simplex* with a few vertical axial grooves and a better defined anterior canal. Atlantic coast conchologists should explain this discrepancy.

D. CYLINDRICAL SPECIES WITH FINE SCULPTURE

Lora schmidti (Friele)

"*Mangilia plicifera* Wood," Schmidt, "Mammuth Exped.," Mém. Acad. Imp. Sci. (St. Petersburg), Ser. 7, Vol. 18, p. —, pl. 4, figs. 4, 5, 1872 (*fide* Krause).

Bela schmidti Friele, Norwegian North Atlantic Exped., Vol. 3, Pt. 16, p. 10, pl. 8, fig. 6, 1886; Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 274, pl. 18, figs. 1, 7, 1886.

Lora tenuissima Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 49, pl. 15, fig. 5, 1919; Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 105, 1927.

Shell of medium size, elongate; whorls only moderately convex, not angulate, sculptured with about 16 small, curving axial ribs, and numerous fine spiral lines; aperture a little longer than half the length of the shell, elongate-ovate, outer lip regularly rounding, curving back posteriorly to a rounded posterior notch, columella nearly straight, anterior canal not defined but the lower end of the aperture narrow; operculum short and broad.

Dimensions: Altitude, 24.5 mm.; length of aperture, 13.5 mm.; diameter of body whorl, 10 mm.

Type specimen: Of *tenuissima*, No. 214,207 in the U. S. National Museum.

Type localities: Of *schmidti*, Norwegian coast (?); of *tenuissima*, Unalaska Island, Alaska.

Distribution: Arctic from Norway to Alaska.

This species somewhat resembles *harpa* Dall, but it has a higher spire, less convex whorls, and finer sculpture with more curving ribs. It is probably more closely related to *Lora violacea*, but can be distinguished by its larger size, its shallower notch, and more distinct axial ribs.

Lora krausei (Dall)

Bela krausei Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 301, pl. 4, fig. 4, October 19, 1886.

Lora krausei Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 46, pl. 15, fig. 3, 1919; Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 107, pl. 7, fig. 7, 1927.

Lora lotta Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 47, pl. 14, fig. 4, 1919, (young, apex eroded); Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 80, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 104, 1927.

Lora lütkeni Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 48, pl. 16, fig. 5, 1919; Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 107, 1927.

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[1] Trans. Conn. Acad. Sci., Vol. 5, p. 471, pl. 57, figs. 12, 12*a*, 1882.

Shell small, elongate; whorls slightly angulated near the top, sculptured with 20 to 26 narrow, curving axial grooves separated by low, wide, flat-topped ridges which are crossed by more closely spaced spiral grooves; aperture half or a little less than half the length of the shell, broadly lenticular or elongate-ovate, outer lip smoothly rounding, curving back to a rather deep posterior notch, inner lip similarly rounding, columella nearly straight, anterior canal not well defined, very short.

Dimensions: Altitude, 9 mm.; length of aperture, 4.7 mm.; diameter of body whorl, 3.2 mm.

Type specimens: Of *krausei,* No. ?, of *lotta,* No. 210,725, of *lütkeni,* No. 220,305, in the U. S. National Museum.

Type localities: Of *krausei,* Port Etches, Alaska; of *lotta,* Queen Charlotte Islands, British Columbia; of *lütkeni,* Port Etches, Alaska.

This at least thrice described species belongs to the same group as *violacea* but is distinguished by the broad, flat interspaces between the axial grooves. The form *exigua* Jeffreys, 1883, looks very much like this species in the illustration; but the description shows that it is more like *expansa,* to which it is here referred.

Variety **krausei**, s. s.

Shell with the axial grooves distinct.

Lora krausei (Dall) variety **regulus** Dall

Lora regulus Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 48, pl. 15, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 102, 1927.

Shell like that of the typical variety but with indistinct and somewhat straighter axial sculpture.

Dimensions: Altitude, 8 mm.; length of aperture, 4 mm.; diameter of body whorl, 3 mm.

Type specimen: No. 207,262 in the U. S. National Museum.

Type locality: Off Point Reyes, middle California, in 61 fathoms. Known only from this locality.

This form is so like the typical variety in all the details of shape that the suggestion is natural that it may be merely a worn specimen of the typical variety. It was probably described from a single specimen.

Lora bicarinata (Couthouy)

Pleurotoma bicarinata Couthouy, Bost. Journ. Nat. Hist., Vol. 2, p. 104, pl. 1, fig. 11, 1838.

Bela bicarinata Couthouy, Sars, Moll. Reg. Arct. Norv., p. 237, pl. 16, fig. 11 (var. *rufescens*), fig. 12, pl. IX, fig. 7, 1878; Verrill, Trans. Conn. Acad. Sci., Vol. 5, pp. 481, 482, pl. 57, figs. 16, 16*a*, 1882; Tryon, Man. Conch., Vol. 6, p. 214, pl. 28, fig. 32, 1884; Friele, Norwegian North Atlantic Exped., Vol. 3, Pt. 16, p. 15, pl. 8, fig. 18, 1886; Vol. 7, Pt. 28, p. 92, 1901; Dautzenberg and Fischer, Rés. Camp. Sci. Albert I, Prince de Monaco, Vol. 37, p. 44, 1912; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 300, pl. 32, fig. 27, 1915.

Lora bicarinata Couthouy, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 110, 1927.

Shell small, spire elevated, characterized by revolving cords, two of which are sometimes prominent, growth lines comparatively weak in the typical form; aperture about half the length of the shell, elongate, posterior notch situated above the uppermost strong cord, of variable depth, rounded, anterior canal not defined; operculum ovate.

Dimensions: Altitude, 9 mm.; length of aperture, 4.5 mm.; diameter of body whorl, 4 mm.

Type specimen: In the collection of the Boston Society of Natural History.

Type locality: Massachusetts Bay.

Distribution: Circumboreal; in the Atlantic, south to Cape Cod and along the coast of Norway; in the Pacific, to Vancouver Island.

This species is very well marked, at least in its typical form. The typical form has two of the spiral cords stronger than the others, giving the whorls a bicarinate appearance; but it grades through an unbroken series into forms that have spiral striæ no stronger than the growth lines. The posterior notch is shallow in the carinate varieties; but it becomes more evident in the more nearly smooth, round-whorled varieties and is in them intermediate between the deep notch of *tenuicostata* and the almost obsolete notch of *expansa*.

Variety **bicarinata**, s. s.

Shell with two strong, keel-like cords showing on the spire whorls and on the upper part of the body whorl, giving the early whorls, especially, an angulated appearance; minor cords on the lower part of the body whorl and sometimes also above, one or two showing between and below the main cords; posterior notch shallow.

Lora bicarinata (Couthouy) variety **exserta** (Aurivillius)

Bela bicarinata Couthouy var. *exserta* Aurivillius, Vega-Expeditions Vetenskapliga Iakttagelser, etc., Vol. 4, pp. 347, 376, 1885 (Note: The Catalogue of the Natural History Books in the Library of the British Museum gives the date as 1887, but all other authors quote 1885).

Bela violacea Mighels and Adams var. *nodulosa* Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 277, pl. 18, figs. 4, 12, 1886.

Lora althorpensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 49, pl. 16, fig. 11, 1919; Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 97, 1927.

Lora bicarinata exserta Aurivillius, Dall, Bull. 112 U. S. Nat. Mus., p. 76, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 110, 1927.

Lora nodulosa Krause, Dall, Bull. 112 U. S. Nat. Mus., p. 78, 1921; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 121, pl. 11, fig. 4, 1927.

Shell like that of the typical variety but with stronger axial riblets, the riblets producing little node-like beads where they cross the two spiral carinæ; the posterior notch practically obsolete, the riblets passing in almost a straight line vertically from suture to suture, columella somewhat longer than in the typical variety.

Dimensions: Altitude, 12 mm.; length of aperture, 6.5 mm.; diameter of body whorl, 5 mm.

Type specimens: Of *exserta*, at Stockholm (?); of *nodulosa*, in the Stuttgart Royal Cabinet (*fide* Oldroyd); of *althorpensis*, No. 208,558 in the U. S. National Museum.

Type localities: Of *exserta*, Pitlekaj, Peninsula of Tschuktschen, northwest of Bering Strait; of *nodulosa*, St. Lawrence Bay, Bering Strait; of *althorpensis*, Port Althorp, Alaska.

Distribution: Bering Strait to the Aleutians and Cook's Inlet.

The following is a translation of Aurivillius' description:

Whorls 5½, canal longer than in *bicarinata*, last whorl with quite distinct spiral costæ and sulci, most finely and abundantly sulcate between the largest (the posterior) costa and the suture; all the whorls except the last with conspicuous longitudinal costæ before the middle.

Lora bicarinata (Couthouy) variety **maurellei** (Dall and Bartsch)

Bela maurellei Dall and Bartsch, Canada Dept. Mines, Geol. Survey Branch, Memoir No. 14-N, p. 10, pl. 1, fig. 5, 1910.

Lora maurellei Dall and Bartsch, Dall, Bull. 112 U. S. Nat. Mus., p. 74, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 79, pl. 12, fig. 5, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 99, pl. 11, fig. 11, 1927.

Shell like that of the typical variety but with two or three more of the spiral cords, besides the normal two, accentuated.

Dimensions: Altitude, 8.5 mm.; length of aperture, 4 mm.; diameter of body whorl, 3.5 mm.

Type specimen: In the U. S. National Museum (*fide* Oldroyd), or in the Geological Survey Museum, Ottawa ?.

Type locality: Barkley Sound, Vancouver Island; known only from there.

This variety is interesting because it extends the range of the species to the southward. It strongly recalls *Teres anceps* (Eichwald).

Lora bicarinata (Couthouy) variety **violacea** (Mighels and C. B. Adams)

Pleurotoma violacea Mighels and C. B. Adams, Bost. Journ. Nat. Hist., Vol. 4, p. 51, pl. 4, figs. 21, January, 1842.
Defrancia cylindracea Möller, Index Molluscorum Groenlandiæ, p. 13, 1842.
? *Defrancia beckii* Möller, *op. cit.*, p. 14, 1842.
? *Defrancia livida* Möller, *op. cit.*, p. 14, 1842.
? *Pleurotoma greenlandica* Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 37, species 343, 1846.
? *Pleurotoma borealis* Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 31, species 277, name in index and in errata following the index, 1846.
Bela violacea Mighels and Adams, Sars, Moll. Reg. Arct. Norv., p. 238, pl. 17, fig. 2, and fig. 3 (var. *lævior*), pl. IX, fig. 8, 1878; Tryon, Man. Conch., Vol. 6, p. 215, pl. 28, figs. 33, 34, 1884; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 292, pl. 32, figs. 25, 26, 1915.
? *Bela decussata* var. *pusilla* Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 480, 1882.
Bela bicarinata var. *violacea* Mighels and Adams, Verrill, Trans. Conn. Acad. Sci., Vol. 5, pp. 482, 483, 1882.
Lora violacea Mighels and Adams, Dall, Bull. 112 U. S. Nat. Mus., p. 78, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 121, 1927.
? *Lora beckii* Möller, Dall, Bull. 112 U. S. Nat. Mus., p. 78, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 122, 1927.

Shell like that of the typical variety but with the spiral cords finer and none of them prominently accentuated except in some cases on the earlier whorls, earlier whorls with a somewhat angulated appearance showing the relationship between this variety and the typical form; posterior notch fairly deep, rounded, close to the suture.

Dimensions: Altitude, 8 mm.; length of aperture, 3.5 mm.; diameter of body whorl, 3 mm.

Type specimens: Of *violacea* at Amherst College, Mass.; of Möller's species, at Copenhagen; of Reeve's, in the British Museum (?).

Type localities: Of *violacea* and *pusilla*, Casco Bay, Maine; of the other names, Greenland.

Fossil: On Gravina Island (Dall); Pliocene and Pleistocene of England (Harmer).
Living: Circumboreal; in the Atlantic south to Norway and to Maine; in the Pacific, Alaska.

Although this variety has quite a different appearance from the typical carinate form, it is recognized by all the writers who have had much material to study as unquestionably a variational extreme. Tryon arranges Sars' figures to illustrate the gradational series. Dautzenberg and Fischer list *violacea* as a synonym of *bicarinata*.

L. tenuicostata is very similar to this variety but shows no traces of angulation on the early whorls; all the whorls are more regularly rounded and inflated, and the posterior notch is deeper. It is possible that some of the synonyms listed questionably here belong to *tenuicostata*. Dall thought that *beckii* might be the young of *tenuilirata;* and both *beckii* and *livida* are described as shorter spired than *cylindracea*, which equals *violacea*. *L. expansa* is also closely related, but can be distinguished by its nearly straight axial striations and by the complete lack of any traces of angulation.

Lora tenuicostata Sars

Bela tenuicostata M. Sars, Videnskabs-Selskabet (Christiania), Forhandlinger, p. 259, 1868 (*fide* Dall).
Bela tenuicostata G. O. Sars, Moll. Reg. Arct. Norv., p. 237, pl. 17, figs. 1*a*, 1*b*, pl. IX, fig. 6, 1878; Tryon, Man. Conch., Vol. 6, p. 217, pl. 28, figs. 35, 36, 1884; Dautzenberg and Fischer, Rés. Camp. Sci. Albert I, Prince de Monaco, Vol. 37, p. 49, 1912.
Bela decussata var. *tenuicostata* Sars, Verrill, Trans. Conn. Acad. Sci., Vol. 5, p. 481, 1882.

Shell small, spire moderately high; whorls rounded, sculptured with numerous small, curving axial riblets crossed by spiral striations; aperture a little more than half as long as the shell, bluntly ovate but not wide, posterior notch deep, rounded, anterior canal very short, poorly defined.
Dimensions: Altitude, 10 mm.; length of aperture, 5.5 mm.; diameter of body whorl, 4.5 mm.

Type specimen: At Christiania.

Type locality: Vadsö, northern Norway.

Distribution: Circumboreal; in the Atlantic, south to Norway and to Maine; in the Pacific, Alaska.

This species is very similar to *bicarinata* var. *violacea* and has about the same distribution. It is not unlikely that it is a synonym of *violacea,* though all the writers have kept it separate.

Lora expansa Sars

Bela ? expansa Sars, Moll. Reg. Arct. Norv., p. 240, pl. 17, fig. 7, 1878; Tryon, Man. Conch., Vol. 6, p. 216, pl. 29, fig. 52, 1884.
Bela exigua Jeffreys, Proc. Zool. Soc. London, p. 398, pl. 44, fig. 10, 1883; Tryon, Man. Conch., Vol. 6, p. 216, pl. 33, fig. 73, 1884.
Bela albrechti Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 276, pl. 18, figs. 3, 11, 1886; ? not "*albrechti* Krause" Dall.
Lora albrechti Krause, Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 106, in part, pl. 11, fig. 5, 1927.

Shell small, spire half the length of the last whorl; whorls regularly rounded, inflated, sculptured with fine, straight axial ribs and about equally fine spiral striations; aperture about half the length of the shell, ovate, posterior notch obsolete; operculate.
Dimensions: Altitude, 9 mm.; length of aperture, 4.7 mm.; diameter of body whorl, 3.5 mm.

Type specimens: Of *expansa,* at Christiania; of *exigua,* in the British Museum (?); of *albrechti,* in the Royal Stuttgart Museum (*fide* Oldroyd).

Type localities: Of *expansa,* Lofoten Islands, northern Norway; of *exigua,* Faroë Channel; of *albrechti,* Plover Bay, Bering Strait.

Distribution: Circumboreal, Norway to Alaska.

This species is very much like *tenuicostata* and *bicarinata* var. *violacea* in general shape but is distinguished by its axial riblets not being curved by the posterior notch. The figure of *exigua* does not exactly match the description. This species also resembles *Thesbia nana* (Lovén), but the latter lacks the axial sculpture and has a more bent columella. Dall's figure of "*albrechti*" looks very different from that of Krause, and unless the figures are very poor probably represents a different species. It is here referred questionably to *lütkeana* (Krause).

Lora lütkeana (Krause)

Bela lütkeana Krause, Archiv für Naturgeschichte, Jahr. 51, Vol. 1, p. 281, pl. 18, figs. 6, 16, 1886.
? "*Bela albrechti* Krause," Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 300, pl. 4, fig. 1, Oct. 19, 1886.
? "*Lora albrechti* Krause," Dall, Bull. 112 U. S. Nat. Mus., p. 75, in part, 1921.
Lora lütkeana Krause, Dall, Bull. 112 U. S. Nat. Mus., p. 75, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 108, pl. 11, fig. 10, 1927.

Shell small, spire high, conical; whorls hardly convex at all, sculptured with straight vertical ridges or grooves crossed by fine spiral striations; aperture about half as long as the shell, in the original deformed (?), elongate-ovate, posterior notch obsolete, anterior canal poorly defined.
Dimensions: Altitude, 12 mm.; length of aperture, 6 mm.; diameter of body whorl, 6 mm. (or 5 mm.).

Type specimen: In the Stuttgart Royal Cabinet (*fide* Oldroyd).

Type locality: St. Lawrence Bay, Bering Strait.

Distribution: In the vicinity of Bering Strait.

This species is distinguished by its peculiar flat-sided whorls and its straight axial sculpture. Dall's identification of *albrechti* is referred here only doubtfully. His figure may be misleading.

Genus DAPHNELLA Hinds, 1844

Daphnella Hinds, Zool. Voy. Sulphur, Moll., p. 25, 1844; Herrmannsen, Ind. Gen. Malac., Vol. 1, p. 370, April, 1847, type cited, *Pleurotoma lymneiformis* Kiener; Tryon, Man. Conch., Vol. 6, pp. 160, 300, 1884; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 126, 1896; Hedley, Rec. Australian Mus., Vol. 13, p. 324, 1922, in part; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 198, 1928.

Type (by subsequent designation, Herrmannsen, 1847), *Pleurotoma lymneiformis* Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, *Pleurotome,* p. 62, pl. 22, figs. 3, 1839-40, also illustrated by Reeve, Conch. Icon., Vol. 1, *Pleurotoma,* pl. 35, species 325, 1846, and by Tryon, Man. Conch., Vol. 6, p. 300, pl. 25, fig. 60, 1884; living, southwestern Pacific.

Shell of medium size, with large, thin, rounding whorls sculptured by fine spiral and sometimes also axial striations; aperture about half the length of the shell, ovate, the inner lip curving in about as much as the outer lip curves out, outer lip thin, simple, rounding back to a shallow posterior notch close to the suture, inner lip and columella not differentiated from the body whorl, columella long, thin, nearly straight, anterior canal not defined, broad, very slightly notched; animal inoperculate.

Geologic range: Eocene to Recent (*fide* Cossmann).

Distribution: Warm and temperate waters of all oceans.

The position of *Daphnella* in the family is uncertain, as the genus has traditionally been classed with *Mangelia* for the insufficient reason that it lacks an operculum. It is similar to *Spergo* Dall,[1] which has a thinner shell and deeper notch, with remnants of axial ribs on the early whorls; and it may be connected through *Spergo* with *Turricula, Pleurotomoides,* and *Lora.* It is very much like *Lora expansa* (Sars). On the other hand, it bears a general resemblance to *Raphitoma,* especially *D. bartschi* Dall, 1919, which appears to have a slightly thickened outer lip.

Daphnella clathrata Gabb is the only characteristic California species.

Daphnella clathrata Gabb

Plate 25, Figures 23, 24

Daphnella clathrata Gabb, Proc. Calif. Acad. Sci., Vol. 3, p. 185, 1865; Dall, Bull. 112 U. S. Nat. Mus., p. 83, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 150, 1927.

Shell much like that of *D. lymneiformis* but with fine axial striations and a slightly longer aperture.

Dimensions: Altitude, 11 mm.; length of aperture, 6 mm.; diameter of body whorl, 4 mm.

Type specimen: At the University of California (?).

Type locality: Catalina Island, California, 60 fathoms.

Living: San Miguel Island, California, to San Diego and Cortez Bank, California (Dall).

This species is very similar to *lymneiformis,* but can be distinguished by the fine axial sculpture. *D. bartschi* Dall, from Lower California, is similar, but has a shorter aperture and apparently a thicker shell. It may be only a variation.

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[1] *Spergo* Dall, Proc. U. S. Nat. Mus., Vol. 17, p. 680, 1894, first species, *S. glandiniformis,* cited as type, Vol. 54, p. 331, 1918.

Genus THESBIA Jeffreys, 1867

Thesbia Jeffreys, Brit. Conch., Vol. 4, p. 359, 1867; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 136, 1896; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 332, 1918.

Type (by monotypy), *Tritonium ? nana* Lovén, "Ind. Moll. Scand.," p. 12, Öfversigt K. Svensk. Vet.-Akad. Förhandl, 1846, illustrated by Sars, Moll. Reg. Arct. Norv., p. 221, pl. 16, fig. 2, 1878, also by Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 461, pl. 112, fig. 8 (in Vol. 4), 1853.

Shell very small, round-whorled, sculptured with spiral grooves or striations; posterior notch entirely obsolete.

Geologic range: Eocene to Recent (*fide* Cossmann).

Distribution: Finland to Great Britain.

This little shell has all the appearances of *Striomitrella*, and the name would be available for that group except for the fact that practically all those who have studied it recently insist on its having a Turrid radula. It is smaller than *Striomitrella*, and may be a dwarfed offshoot from *Lora*.

Genus BORSONIA Bellardi, 1839

Borsonia Bellardi, Bull. Soc. Géol. de France, Vol. 10, p. 30, 1839; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 96, 1896.

Type (by monotypy), *Borsonia prima* Bellardi, *loc. cit.;* figured by Cossmann, *op. cit.*, pl. 6, figs. 18, 20; Miocene of Torino (Turin), Italy.

Shell of medium or small size, not heavy, spire moderately high; whorls of spire usually angulated near the middle and ornamented on the angle with elongate nodes or axial costæ, above the angle the whorls slightly concave and smooth except for curving growth lines, the remainder of each whorl sometimes covered with faint spiral lines, nodes practically obsolete on the last-formed part of the body whorl on many specimens, sutures distinct; aperture elongate, lenticular, nearly half as long as the shell, outer lip simple, curving back near the top into a fairly deep, rounded notch close to the suture, inner lip marked by an area on the body whorl where the outer layer of the shell has been resorbed, columella characteristically nearly straight, slightly oblique, often with a plait on the upper half, the plait sometimes strong, sometimes very weak, sometimes entirely absent, occasionally also a faint second plait or even a third; anterior canal short but usually distinctly defined, not notched.

Geologic range: Eocene to Recent; California, upper Pliocene to Recent.

Distribution: Temperate and subtropical waters of both the Atlantic and Pacific, usually from considerable depth, and from shallower boreal waters.

As has already been recognized by several authors, the presence or absence of the columellar plait cannot be used as the distinguishing characteristic of this genus. The tendency to have a columellar plait may mean something; but it is a fact too often blindly ignored that unrelated species may have similar plaits and that of closely related species or even individuals of the same species one may have a plait and another not. The genus *Borsonia* must be taken into account on the Pacific coast, for *Borsonia bartschi* (Arnold) is so much like *B. prima* that the two are not easy to separate specifically. Dall separated off his genus *Borsonella* on the basis of shape and sculpture, and then included in it species with many different shapes and kinds of sculpture, even those with the shape and sculpture of *Borsonia*.

The problem of finding satisfactory criteria for separating the closely related groups which have been variously named *Pseudomelatoma*, *Eopleurotoma*, *Borsonia*, *Typhlomangelia*, *Spirotropis*, *Borsonella*, and *Antiplanes* is very difficult to solve. It is a problem characteristic of the *Turridæ*, for in this family nearly every group of forms will be found to grade practically without break and by means of species showing baffling combinations of characters and variations into several related groups, the extremes of these related groups being frequently of very diverse nature. The problem is often made particularly hard by the fact that individual variants within species are sometimes so different in form as to bridge the gaps between two or even more genera, as the genera are now commonly considered. This situation has led the writers to the conclusion that the genera have already been divided too finely. *Pseudomelatoma penicillata* and *P. torosa*, though remarkably different in appearance, intergrade so completely that conchologists who are familiar with these forms consider it not unlikely that they are nothing more than geographcial variations of a single specific stock; and yet the distinctions between *P. torosa* and the non-plicated specimens of *Borsonia bartschi* are certainly not of more than specific value, consisting chiefly in the number of nodes to a whorl and the slightly different curves of the columellas, so that prominent paleontologists have mistaken one for the other. The variations of *Borsonia bartschi* that lack the columellar plication are very similar to the type of *Typhlomangelia*. The type of *Borsonella* when without the plait is almost identical with the type of *Spirotropis*, and other specimens of this species show vestiges on the spire whorls of the nodosity characteristic of *Borsonia*. *Antiplanes* is like *Spirotropis* except that it lacks the more or less obscure angulation on the whorls, and it differs only by its thinner shell, more curving columella, and other details from the group of *Pseudomelatoma* on which the sculpture has become obsolete. The extreme forms of *Borsonia* and *Spirotropis* can be distinguished by: (1) presence or absence of sculpture, (2) presence or absence of columellar plait, (3) curvature of columella, (4) relative length of aperture. The extremes are so different that a separation seems desirable, and yet there is no logical place to make the separation. The assignment of species is materially different according to the criterion relied upon, and the use of any one criterion involves the inclusion of some species with others to which they appear more distantly related than they are to some of those from which they are separated. The first criterion is here accepted as the basis, though it is somewhat modified by the apparent interrelations of species and by the other criteria so that *renaudi* and perhaps others may still be assigned to *Spirotropis*, in spite of the vestiges of sculpture they frequently show. The second criterion is here largely discounted, as too often of less than specific value. *Borsonella* is recognized as a subordinate group of *Spirotropis* with a tendency to have a plait.

Cordieria Rouault[1] cannot be separated from *Borsonia* on the basis of columellar plaits alone, as pointed out by Cossmann; but Cossmann considers the shorter canal and various other characters which he enumerates sufficient to distinguish it as a subgenus. Dall records a single species from the Barbados,[2] but there appears to be no record of the subgenus on the Pacific coast. *Eopleurotoma* Cossmann[3] may be considered another subgenus of *Borsonia*, characterized by a row of nodes behind the anal fasciole as in *Pseudomelatoma*. It does not have a plait. It is barely distinguishable from *Pseudomelatoma* by its smaller size, more oblique costæ, and more clearly defined anterior canal. According to Cossmann, this subgenus occurs in the Eocene and Oligocene of Europe and the Eocene (Claiborne) of the United States; and, though still unrecognized, it may be present in the California Eocene. The type of *Typhlomangelia* Sars looks almost exactly like a small

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[1] *Cordieria* Rouault, Bull. Soc. Géol. de France, Ser. 2, Vol. 5, p. 207, 1848, third species, *C. iberica* Rouault; type cited by Cossmann, Ess. Paléo. Comp., Vol. 2, p. 98, 1896, *C. iberica* Rouault, Eocene of France, described and figured by Rouault, Mém. Soc. Géol. de France, 1850 (see Neues Jabrbook für Mineralogie, p. 752, 1851).

[2] *Cordieria rouaultii* Dall, Bull. Mus. Comp. Zool., Vol. 18, p. 98, pl. 36, fig. 11, 1889.

[3] Cossmann, 1889,—See Ess. Paléo. Comp., Vol. 2, p. 80, 1896, type *P. multicostata* Deshayes, Eocene; + *Strombina* de Gregorio, 1890, not Bronn, 1849.

Turricula kaderleyi Lischke. The specimens of *Borsonia bartschi* that lack the columellar plications also resemble Sars' figure of the type of *Typhlomangelia*, except that the columella of the latter is more flexuous, and it is possible that *Typhlomangelia* should be considered a section or a synonym of *Borsonia*. *Typhlomangelia* is described as having an operculum like that of *Spirotropis*, from which it differs in having axial nodes and spiral striation. The position of the posterior notch in *Borsonia* and *Spirotropis* and the form of *Typhlomangelia* suggest that *Turricula* is also closely related. The short oblique costæ on the upper whorls of *Spirotropis renaudi* are analagous to those on *Turricula javana* (Linnæus).

Borsonia bartschi (Arnold)

Plate 26, Figures 27, 28

Pleurotoma (*Borsonia*) *bartschi* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 200, pl. 9, fig. 1, 1903.
? *Pleurotoma* (*Borsonia*) *bartchi* variety *curta* Arnold, *op. cit.*, p. 201, pl. 5, fig. 7, 1903.
? *Drillia merriami* Arnold, *op. cit.*, p. 207, pl. 8, fig. 7, 1903.
Borsonia bartschi Arnold, Buell, Nautilus, Vol. 24, p. 142, 1911.
? *Drillia merriami* Arnold, Buell, *op. cit.*, p. 143, 1911.
Borsonella nicoli Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 39, pl. 12, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 95, 1927.
Borsonella barschi Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 73, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 93, 1927.

Shell relatively small, with a moderately high spire; whorls seven or eight, somewhat angulated, ornamented with 9 to 12 axially elongate nodes on the angle; aperture about two-fifths the length of the shell, elongate, lenticular, outer lip smooth, with a moderately deep, rounded notch near the top, columella nearly straight, sometimes with a strong or faint plait two-thirds of the distance up, sometimes with the plait entirely obsolete, anterior canal short, broad.

Dimensions: Altitude, 19 mm.; length of aperture (including canal), 8 mm.; diameter, 7 mm.

Type specimens: Of *bartschi*, No. 162,535, of *merriami*, No. 162,536, of *nicoli*, No. 198,925, in the U. S. National Museum; of *curta*, No. 427 in the type collection at Stanford University.

Type localities: Of *bartschi*, *curta*, and *merriami*, lower San Pedro Pleistocene of Deadman Island, San Pedro; of *nicoli*, southwest of San Nicolas Island in 158 fathoms.

Pleistocene: "Pliocene" of Deadman Island (Arnold); Santa Monica (Rivers); lower San Pedro series of Deadman Island (Arnold), and San Pedro (T. S. Oldroyd).
Living: San Nicolas Island to San Diego.

The form *merriami* was distinguished from *bartschi* principally by the lack of the columellar plait. In this connection the remarks by Miss Buell on the specimens in the Rivers Collection from the Pliocene or Pleistocene of Santa Monica are interesting:

> "Of 70 specimens studied, 20 show plications faint to obsolete in most individuals, one has three, and one has two faint ridges on the columella. About half have transverse ribs on the body whorl, and the rest are marked like *D. renaudi*, but with fewer whorls."

It is implied that 48 specimens did not show the plications, and it is specifically stated in the paragraph preceding the one quoted that of 27 specimens of *Borsonia hooveri* ten lacked the plication. Arnold would probably have classed the specimens without plications as *merriami*. Rivers appears to have used some other criteria for distinguishing the two forms, for Miss Buell also lists *Drillia merriami* and explains that out of ten specimens three have plications. The only specimen in the Arnold Collection at Stanford University labeled *merriami* has an extremely faint plication, so faint that the writers overlooked it for some time. The evidence is fairly conclusive that the presence or absence of the columellar plait is not of specific significance in this group, and it is probable that the other characters used to distinguish *merriami* can be assigned to variation within the species. The variety *curta* is probably also without significance. Dall's description and figure of the living form *nicoli* are practically identical with the original description and figure of *bartschi*. Dall records *bartschi* also as living.

Borsonia bartschi is distinguished from *Pseudomelatoma torosa* by the plait, when it is present, and by its smaller, more numerous, and more elongate nodes. The columella is apt to be slightly convex instead of concave.

Borsonia nychia (Dall)

Borsonella nychia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 38, pl. 12, fig. 2, 1919; Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 94, 1927.

Shell fairly small, biconical, body whorl angulated; a row of 9 to 11 small, sharp nodes on the angle of the body whorl, appearing just above the suture on the spire whorls; columella practically straight, with or without an obscure plication on the upper part.

Dimensions: Altitude, 15 mm.; length of aperture (including canal), 7 mm.; diameter, 6.5 mm.

Type specimen: No. 208,891 in the U. S. National Museum.

Type locality: Off Point Loma, San Diego Co., California.

Pleistocene: Lower San Pedro series of Deadman Island (Arnold Collection, labeled "near *merriami*").
Recent: Type locality only.

This species is distinguished from *B. bartschi* by the small, sharp nodes on the angle and by the short conical spire. The columella is much straighter than that of *Spirotropis herminea* (Dall). The shell is shorter and the columella is straighter than that of *Spirotropis renaudi* (Arnold), but the latter has similar nodes on the angle and is closely related. The columellar plication does not show on the Pleistocene specimen.

Genus SPIROTROPIS Sars, 1878

Spirotropis Sars, Moll. Reg. Arct. Norv., p. 242, 1878; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 88, 1896; Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, pt. 2, p. 230, 1915.

Type (by monotypy), "*Spirotropis carinata* Philippi" Sars, *op. cit.*, p. 242, pl. 17, figs. 5*a*, 5*b;* also figured by Cossmann, *op. cit.*, p. 88, pl. 5, figs. 26, 27, and by Harmer, *op. cit.*, pl. 28, figs. 10; = *? Pleurotoma carinatum* Philippi, Enum. Moll. Siciliæ, Vol. 2, p. 176, pl. 26, fig. 19, 1844; Tryon, Man. Conch., Vol. 6, pp. 213, 388, pl. 7, fig. 94, 1884; = *? Fusus modiolus* Jan, 1832, *Spirotropis modiola* (Jan), Harmer, *op. cit.*, p. 230, pl. 28, figs. 9, 11, 12.

Shell of medium or small size, varying in thickness, high or medium spired; protoconch of about two whorls, smooth, rounded, adult whorls rounded or angulated, usually smooth except for growth lines but sometimes with fine, shallow spiral striations or with vestiges of nodes on the early whorls; aperture about a third or two-fifths the length of the shell, rectangular or elliptical, oblique, outer lip thin, curving back strongly near the top into a broad, deep, rounded posterior notch, which is fairly close to the suture in the type but is more distant in the species related to *Monitiopsis*, inner lip marked by an area in which the exterior layer of the body whorl has been resorbed, columella often slender and flexuous, with the upper part of the whorl curving in abruptly toward it, or the columella nearly straight, with a columellar plication, and the body whorl only gently curving as in *Borsonia*, anterior canal short or of medium length, parallel-sided, indistinctly defined; operculum horny, pyriform, with a terminal nucleus.

Geologic range: Miocene to Recent (Cossmann; Harmer); in California, Eocene to Recent.

Distribution: Arctic and temperate waters of both the Atlantic and the Pacific.

Cossmann refers the species *carinata* to Bivona in one place and to Philippi in another, but gives no reference. Philippi's *carinata* as reproduced by Tryon has a strong carination and an elongate columella and appears to be the same as the fossil specimens of *modiola* figured by Harmer. The living Scandinavian form figured and described by Sars and others is much less carinate and has a shorter columella, having practically the same shape as *Spirotropis coronadoi* (Dall), the type of *Borsonella*, and *S. renaudi* (Arnold). Sars' figure is here accepted as the type of the genus, regardless of what form Philippi may have had, though the two forms are so closely related that they should almost surely be classed in the same genus.

The specimen figured by Cossmann has the notch immediately under the suture and resembles somewhat a form of *Clavus* (*Cymatosyrinx*) sp. with the sculpture obsolete. Also, as pointed out by Thiele,[1] the radula of *Spirotropis* is similar to that of *Cymatosyrinx, Drillia*, etc., so that the conclusion is suggested that *Spirotropis* is related rather to the *Clavus* branch of the family than to the *Moniliopsis* branch. However, this argument offers the only valid reason for separating *Antiplanes* from *Spirotropis;* and it is not accepted here, for the specimen figured by Sars can scarcely be distinguished specifically from some of the smaller dextral species of the Pacific which have been assigned to *Antiplanes*, and Sars expressly states that the sinus is "*a sutura remoto*." It must be remembered that this branch of the family is intermediate in characters between the *Clavus* branch and the *Turricula* branch, grading laterally into each, and it is to be expected that some of the forms will show characters usually confined to one of these other branches of the family. As explained above, the species are practically inextricably bound up with related forms in *Borsonia, Pseudomelatoma*, and *Moniliopsis;* and this argument seems to be a much more valid reason for grouping typical *Spirotropis* here than for relating it to the *Clavus* branch on account of the characters of the notch and radula, the notch being inconstant and more often like the notch of *Turricula*, and the radula being unreliable, as it is known from only a few specimens.

Typical *Spirotropis* is distinguished from *Aforia* by its smaller size and shorter canal. It also resembles *Pleurotomoides* in its notch, but differs in its higher spire and lack of sculpture. The subgenera *Typhlomangelia* and *Borsonella* grade into *Borsonia*, the former differing from *Borsonia* only in its flexuous, non-plicated columella, the latter in its lack of sculpture. *S.* (*Borsonella*) *omphale* Dall might better be classed with *Moniliopsis*, in spite of its columellar plication. The subgenus *Antiplanes* is very much like the smooth forms of *Pseudomelatoma* (i. e., *Lævitectum*), and the whole group is connected with typical *Pseudomelatoma* through *Borsonia*, with and without the plication. In a number of respects the forms of *Typhlomangelia* resemble small Turriculas; and such species as *Turricula piercei* (Arnold) suggest strongly a direct intergradation between this genus and *Turricula*, and possibly also *Surculites*.

Subgenus **SPIROTROPIS**, s. s.

Shell smooth except for growth lines, whorls shouldered or carinated, columella gently flexuous, without plication.

Besides the type species, which is known from the Miocene to the Recent in Europe, this subgenus appears to include a number of deep-water Pacific coast forms which are as yet only known living, and probably also several Miocene and Oligocene species. The intermediate record appears to be missing. Probably most of the following species should be included in this subgenus:

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[1] Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, p. 203, 1925.

Spirotropis kincaidi (Weaver)

Turris kincaidi Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 53, pl. 5, fig. 67, 1916.

Oligocene of Washington.

Spirotropis dickersoni (Weaver)

Turris dickersoni Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 54, pl. 5, fig. 66, 1916.

With the last.

Spirotropis polycaste (Dall)

Cryptogemma polycaste Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 30, pl. 9, figs. 4, 7, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 79, 1927.

Living, Oregon to Lower California. Like the strongly carinated forms of the type species; also similar to *S. kincaidi.*

Spirotropis adrastia (Dall)

Cryptogemma adrastia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 33, pl. 19, fig. 2, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 80, pl. 11, fig. 2, 1927.

Monterey to San Diego in deep water. Similar to *polycaste.*

Spirotropis chrysothemis (Dall)

Cryptogemma chrysothemis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 31, pl. 11, fig. 2, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 80, pl. 19, fig. 1, 1927.

Living near Catalina Island, California. Small, biconic, with a little carina on the not very prominent shoulder.

Spirotropis cymothoe (Dall)

Cryptogemma cymothoe Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 31, pl. 9, fig. 3, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 79, 1927.

Santa Barbara Islands to San Diego in deep water. Like *chrysothemis.*

Spirotropis antigone (Dall)

Cryptogemma antigone Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 32, pl. 11, fig. 4, 1919.
Antiplanes antigone Dall, Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 89, 1927.

San Diego in deep water. Like *chrysothemis* with a slightly weaker carina.

Spirotropis agamedea (Dall)

Antiplanes agamedea Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 33, pl. 24, fig. 2, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 90, 1927.

Living, Cape San Quintin, Lower California. Similar to *chrysothemis.*

Spirotropis ? evadne (Dall)

Mangilia evadne Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 69, pl. 23, fig. 2, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 137, 1927.
Not *Pleurotomella evadne* Melvill, Proc. Malac. Soc. London, Vol. 10, p. 252, pl. 12, fig. 18, 1912.

Living, off Santa Rosa Island, California, in not such deep water as the others. Similar to *polycaste* but with a shorter columella, stronger carina, and some auxiliary spirals. Dall says that this species cannot be classed with the others because it is so small; but his own dimensions show that some of the others are smaller.

Subgenus **TYPHLOMANGELIA** Sars, 1878

Typhlomangelia (M. Sars MS) G. O. Sars, Moll. Reg. Arct. Norv., p. 241, 1878; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 63, 1896.

Type (by monotypy), *Pleurotoma nivale* Lovén, figured by Sars, *op. cit.*, pl. 17, fig. 6.

Shell like that of the typical subgenus except that on the angle of the spire whorls there are often obscure nodes as in *Borsonia* or *Turricula*, and there are sometimes faint spiral striations on both the spire and body whorls.

This group shows the relationship between *Spirotropis* and *Borsonia*, and suggests a similarity with *Turricula*. It has an operculum like that of the typical subgenus.

Spirotropis (Typhlomangelia) renaudi (Arnold)

Plate 26, Figure 29

Drilla renaudi Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 208, pl. 8, fig. 5, 1903; Buell, Nautilus, Vol. 24, p. 143, 1911.
Turris (*Drillia*) *renaudi* Arnold, Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, 1916.
Antiplanes amycus Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 36, pl. 11, fig. 5, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 89, 1927.
Clathrodrillia renaudi Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 69, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 70, 1927.

Shell small, high-spired, with about eight whorls; protoconch smooth, rounded, of about a whorl and a half, spire whorls angulated, with about fifteen sharp, rounded, little nodes on the angle of each whorl, the nodes being prolonged obliquely downward toward the suture, body whorl rounded and nearly smooth except for growth lines; aperture two-fifths the length of shell, small, ovate, extending downward into a distinctly defined anterior canal, outer lip thin and sharp, curving backwards at the top into a fairly deep, rounded posterior notch, columella flexuous, partially resorbed.

Dimensions: Altitude, 15.5 mm.; length of aperture (including canal), 6.5 mm.; diameter of body whorl, 6 mm.

Type specimens: Of *renaudi*, No. 428 in the type collection at Stanford University; of *amycus*, No. 226,163 in the U. S. National Museum.

Type localities: Of *renaudi*, lower San Pedro series, Pleistocene, of Deadman Island, California; of *amycus*, living, Monterey Bay, California.

? U. Pliocene: Santa Barbara horizon, Fourth and Broadway, Los Angeles (Moody); of loc. 218 S. D. S. N. H., Sulphur Canyon, east of South Mt., Ventura Co., one speciemn (H. R. G.).
Pleistocene: "Pliocene" of Deadman Island, one specimen (Arnold); type locality, one specimen (Arnold); "Pliocene" of Santa Monica, Rivers Collection (Buell).
Living: Monterey Bay to San Pedro, deep water.

This interesting species helps to form the connection between *Borsonia* and *Spirotropis*. Miss Buell says of the specimens in the Rivers collection: "Of 27 specimens examined, 10 agree in form and surface markings with *B. bartschi*. One has columellar fold almost obsolete, 20 agree with the type in the absence of ribs on the body whorl, but have from one to three fewer whorls, while 8 have faint plications on the inner lip." This species is distinguished from *B. bartschi* by its smaller, sharper, more oblique nodes, its smooth and more rounded body whorl, and its more flexuous columella. *B. bartschi* occasionally lacks the plication on the columella, and *S. renaudi* occasionally has one.

The following species, known only living, may also be assigned to this subgenus:

Spirotropis (Typhlomangelia) herminea (Dall)

Pleurotomella herminea Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 50, pl. 3, fig. 6, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 125, pl. 3, fig. 1, 1927.

Like *S. renaudi*, but relatively broader, with fewer nodes, more twisted columella, and faint spiral sculpture. Catalina Island, California, deep water.

Spirotropis (Typhlomangelia) rhodope (Dall)

Borsonella rhodope Dall. Proc. U. S. Nat. Mus., Vol. 56, p. 39, pl. 12, fig. 3, 1919; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 93, 1927.

The shape of *S. renaudi*, but without nodes and with traces of spiral sculpture. Santa Rosa Island to San Diego, California.

Subgenus **BORSONELLA** Dall, 1908

Borsonella Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 258, 1908; Proc. U. S. Nat. Mus., Vol. 54, p. 319, 1918.

Type (by original designation), *Pleurotoma* (*Borsonia*) *dalli* Arnold, 1903; not *Pleurotoma dalli* Verrill and Smith, 1882; = *Borsonia* (*Borsonella*) *coronadoi* Dall, 1908; + *Borsonella angelana* Hanna, 1924, new name for *dalli* Arnold.

Shell like that of the typical subgenus except that the columella is nearly straight and often has a fold on the upper part.

This group is distinguished from *Borsonia* by its lack of axial ribs or nodes, and from the other subgenera of *Spirotropis* by its nearly straight columella, which has a tendency to have a plication on the upper part.

Spirotropis (Borsonella) hooveri (Arnold)

Pleurotoma (*Borsonia*) *hooveri* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 201, pl. 10, fig. 1, 1903.

Borsonia (*Borsonella*) *hooveri* Arnold, Dall, Bull. Mus. Comp. Zool., Vol. 43, p. 276, pl. 13, fig. 7, 1908.

Borsonia hooveri Arnold, Buell, Nautilus, Vol. 24, p. 142, 1911.

Shell of medium size, biconical, short, with about six whorls; whorls smooth, angulated, suture impressed; aperture elongate, rectangular, usually with a plication on the upper part of the columella.

Dimensions (from Arnold): Longitude, 13 mm.; latitude, 6.5 mm.; body whorl, 8.2 mm.; aperture, including canal, 6.5 mm.; deflection, 50°.

Type specimen: No. 162,533 in the U. S. National Museum.

Type locality: Lower San Pedro series, Pleistocene, of Deadman Island, San Pedro, California.

Pleistocene: Type locality; "Pliocene" of Santa Monica, Rivers Collection (Buell).
Living: Mazatlan, Mexico, to Ecuador (Dall).

This species is the short-spired extreme of its group. It grades through imperceptible gradations into higher spired forms which are like it in every respect except in the height of the spire, into *barbarensis* first and then into the high-spired extreme *coronadoi*. The intergrades appear to be more numerous than the extremes, and it is very probable that all three forms belong to a single, variable specific stock and should perhaps be listed as varieties of *hooveri*, the form with the oldest valid name. *S. hooveri* grades into *S. renaudi* in a similar manner by a heightening of the spire when there are remnants of nodes on the angles. Miss Buell's remarks on the specimens in the Rivers Collection are interesting, although Rivers' assignment of the specimens to species may have been inaccurate: "Of 27 specimens examined, 16 have faint to obsolete columellar plications. One shows three faint ridges, while the rest lack the subgeneric distinction entirely. All agree in outline and number of whorls with Arnold's type, but about half have almost obsolete nodes on apical whorl like *D. renaudi* Arnold, which this approaches."

Spirotropis (Borsonella) barbarensis (Dall)

"*Borsonia* (*Borsonella*) *dalli* Arnold," Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, p. 275, pl. 13, fig. 9, 1908.

Borsonella barbarensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 37, pl. 12, fig. 6, 1919; Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 92, pl. 6, fig. 10, 1927.

"*Borsonella dalli* Arnold," Dall, Bull. 112 U. S. Nat. Mus., p. 72, in part, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 91, in part, pl. 6, fig. 8, 1927.

Shell like the shells of *S. hooveri* and *S. coronadoi* but with a spire of intermediate height.

Dimensions (of Pleistocene specimen): Altitude, 22 mm.; length of aperture, including canal, 11 mm.; diameter of body whorl, 9 mm.

Type specimen: No. 96,841 in the U. S. National Museum.

Type locality: Off Santa Barbara Island, California.

Pleistocene: San Pedro district, one specimen (Arnold Collection).
Living: Middle California to Lower California.

Apparently the type of *barbarensis* was in the material from which Dall's 1908 figure of "*dalli*," reproduced by Oldroyd, was drawn. The Pleistocene specimen is a little more round-whorled than Dall's type, but is very close.

Spirotropis (Borsonella) coronadoi (Dall)

Pleurotoma (*Borsonia*) *dalli* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 201, pl. 6, fig. 2, 1903; not *Pleurotoma dalli* Verrill and Smith, Trans. Conn. Acad. Sci., Vol. 5, p. 451, pl. 57, figs. 1, 1*a*, 1882.

Borsonia (*Borsonella*) *coronadoi* Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, p. 277, pl. 14, fig. 2, 1908.

Borsonia dalli Arnold, Buell, Nautilus, Vol. 24, p. 143, 1911.

Borsonella dalli Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 72, in part, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 91, in part, not pl. 6, fig. 8, 1927.

Borsonella coronadoi Dall, Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 91, 1927.

Borsonella angelana Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 158, 1924, new name for *Pleurotoma dalli* Arnold.

Shell like that of *S. hooveri* but with a higher spire.

Dimensions (from Dall): Longitude of shell, 29 mm.; of last whorl, 16.5 mm.; of aperture, 12 mm.; maximum diameter, 9 mm.

Type specimens: Of *coronadoi*, No. 110,608 in the U. S. National Museum; of *angelana*, No. 162,534 in the U. S. National Museum.

Type localities: Of *coronadoi*, Los Coronados Island, California, near the Mexican boundary; of *angelana*, lower San Pedro series, Pleistocene, of Deadman Island, San Pedro, California.

Pleistocene: Type locality of *dalli* = *angelana*, rare; "Pliocene" of Deadman Island, rare (Arnold); "Pliocene" of Santa Monica, Rivers Collection (Buell).
Living: San Clemente Island, California, to the Coronado Islands.

For a comparison of the forms *hooveri*, *barbarensis*, and *coronadoi*, it might be noted that in specimens with a body-whorl diameter of 9 mm. the altitudes would be 18 mm., 22 mm., and 29 mm., respectively. The form *coronadoi*, when it has nodes on the angle, passes over into *S. renaudi*.

Spirotropis (Borsonella) diegensis (Dall)

Borsonia (*Borsonella*) *diegensis* Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 43, p. 275, pl. 13, fig. 11, 1908.

Borsonella diegensis Dall, Bull. 112 U. S. Nat. Mus., p. 73, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 92, pl. 6, fig. 4, 1927.

Shell like that of *S. barbarensis* but with the shoulder pinched up into a carina as in some forms of typical *Spirotropis*.

Dimensions (from Dall): Length of four whorls, 15 mm.; of last whorl, 12.5 mm.; of aperture, 9.5 mm.; maximum diameter, 8 mm.

Type specimen: No. 122,573 in the U. S. National Museum.

Type locality: Off San Diego in deep water.

Living: San Diego to Ecuador.

This species is interesting as illustrating another combination of subgeneric characters.

Spirotropis (Borsonella) abarbarea (Dall)

Antiplanes abarbarea Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 35, pl. 9, fig. 5, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 86, pl. 3, fig. 6, 1927.

Shell with the general shape of *S. barbarensis* but with less angulated whorls and lacking the columellar plication.

Dimensions (from Dall): Height of shell 21.5 mm.; of last whorl, 13.5 mm.; diameter, 8 mm.

Type specimen: No. 224,393 in the U. S. National Museum.

Type locality: Off Santa Rosa Island, California.

Living: Cape Martin to Cortez Bank, California (Dall).

This form appears to be one of the variants of *barbarensis* which lack the plication. Such variants of other species have been repeatedly noted above. It resembles *Pseudomelatoma penicillata* variety *moesta* (Carpenter), but can be distinguished by its slightly convex columella and by its lack of nodes above the slit band (anal fasciole).

? Spirotropis (Borsonella) omphale (Dall)

Borsonella omphale Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 38, pl. 12, fig. 4, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 90, pl. 19, fig. 6, 1927.

Shell with the shape and sculpture of *Moniliopsis incisa* (Carpenter) but with a columellar plication.

Dimensions (from Dall): Height of shell, 16 mm.; of last whorl, 10 mm.; diameter, 6 mm.

Type specimen: No. 209,174 in the U. S. National Museum.

Type locality: Point Loma, San Diego County, California, in deep water. Not known elsewhere.

This species does not look like the other members of the subgenus *Borsonella*, and it is so very similar to *Moniliopsis* that it very probably should be classed in that genus in spite of the columellar plication, which, as we have seen, is not a constant character. This species again illustrates the closeness of the interrelations between the groups of this branch of the family as here outlined. It has the elevated spire more characteristic of the subgenus *Antiplanes*.

Subgenus ANTIPLANES Dall, 1902

Antiplanes Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 513, 1902.

Type (by original designation), *Pleurotoma* (*Surcula*) *perversa* Gabb.

Shell like that of the typical subgenus but more characteristically larger, with rounded whorls and higher spire; tending to be sinistral.

Geologic range: Eocene to Recent (*Drillia cooperi* Dickerson from the Tejon Eocene appears to be the earliest record).

Distribution: North Pacific, mostly in deep water.

The larger, more extreme, high-spired forms of this subgenus appear quite different from the smaller, carinated, typical forms, but the intergradations are so complex that it seems to express the truth better to draw attention to the relationship by treating this group as a subgenus. Some of the deep-water species of *Antiplanes* such as *S. amphitrite* are smaller than the type of *Spirotropis* figured by Sars, and they might well be placed with *S. agamedea* and others in the typical section or even in *Typhlomangelia*, except that their relationship with *Antiplanes* through *S. perversa* variety *voyi* seems even closer. The division line between the subgenera is drawn arbitrarily at the point where the angulation of the whorls has become practically obsolete. The subgenus *Antiplanes* is related to *Moniliopsis* through *M. briseis* (Dall), and to *Pseudomelatoma* (*Lævitectum*) through *S.* (*A.*) *bulimoides* (Dall).

The Zoological Record contains many references to descriptions of sinistral monstrosities of normally dextral species. A number of species in various families are recognized to be indifferently dextral or sinistral, and in some cases both dextral and sinistral protoconchs have been found in the same egg capsule. Some of the forms of *Antiplanes* have a *tendency* to be sinistral; but there is no reason to assume that a species which has as a definite character a tendency to be sinistral may not also include dextral individuals. Indeed, the evidence is now practically overwhelming to show that the usually sinistral *perversa* includes a number of dextral individuals. The left-handed and right-handed specimens occur together (until separated by collectors) in practically every locality, showing nearly identical forms and parallel series of variations. The sinistral forms, being more normal for the common species *perversa*, are sometimes more robust. The dextral forms, because rarer and therefore not showing their variability so plainly, have received about twice as many names.

Spirotropis (Antiplanes) perversa (Gabb)

Plate 26, Figures 22, 23*a*, 23*b*

Pleurotoma (*Surcula*) *perversa* Gabb, Proc. Calif. Acad. Sci., Ser. 1, Vol. 3, p. 183, 1865; Geol. Surv. Calif. Palæo., Vol. 2, p. 6, pl. 1, fig. 10, 1866.

Drillia perversa Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 73, 1868-9.

Surcula perversa Gabb, Tryon, Man. Conch., Vol. 6, p. 239, pl. 6, fig. 79, 1884.

Pleurotoma perversa Gabb, Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 260, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 200, 1903; Keep, West American Shells, p. 157, fig. 141, 1904; Buell, Nautilus, Vol. 24, p. 143, 1911; Stewart, Proc. Acad. Nat. Sci., Phila., Vol. 78, p. 291, 1926.

Pleurotoma (*Antiplanes*) *perversa* Gabb, Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 513, pl. 34, fig. 8, 1902; Yabe (*fide* Zoological Record, 1920, but the reference given there deals with Eocene foraminifera only).

Pleurotoma (*Antiplanes*) *thalæa* Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 514, 1902.

Pleurotoma (*Antiplanes*) *santarosana* Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 515, 1902.

Pleurotoma (*Spirotropis*) *smithi* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 216, pl. 6, fig. 13, 1903, not *Pleurotoma smithii* Forbes, Ann. & Mag. Nat. Hist., p. 107, pl. 2, fig. 14, 1840, nor *Pleurotoma trevelyana smithii* Jeffreys, Ann. and Mag. Nat. Hist., p. 332, 1876.

Pleurotoma (*Antiplanes*) *catalinæ* Raymond, Nautilus, Vol. 18, p. 2, 1904.

Turris (*Antiplanes*) *perversa* Gabb, Dall, Prof. Paper 59 U. S. Geol. Survey, p. 26, pl. 5, fig. 5, 1909.

Spirotropis smithi Arnold, Buell, Nautilus, Vol. 24, p. 143, 1911.

Turris perversa Gabb, Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, pp. 591, 594, 597, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, pp. 239, 258, 1916; Moody, Vol. 10, p. 44, 1916; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 342, pl. 41, figs. 3*a*, 3*b*, 1918; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93, 1922.

Turris smithi Arnold, Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, pp. 596, 597, 1913.

Crassispira perversa Gabb, Willett, Nautilus, Vol. 33, p. 21, 1919.

Crassispira rotula Dall, Willett, Nautilus, Vol. 33, p. 21, July, 1919, a manuscript name ?.

Antiplanes santarosana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 36, pl. 11, fig. 3, August 8, 1919; Bull. 112 U. S. Nat. Mus., p. 71, pl. 1, fig. 9, not fig. 8, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 84, pl. 3, fig. 8, pl. 6, fig. 3, not fig. 1, 1927.

Antiplanes thalæa Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 37, not pl. 11, fig. 6, 1919; Bull. 112 U. S. Nat. Mus., p. 72, pl. 1, fig. 8, not fig. 9, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 4, pl. 22, fig. 1, 1925; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 85, pl. 6, fig. 1, not fig. 3 nor pl. 3, fig. 8, 1927.

Antiplanes rotula Dall, Bull. 112 U. S. Nat. Mus., pp. 71, 200, 1921, new name for *smithi* Arnold, not Forbes, "Dall 1919" cited by mistake (?); Proc. U. S. Nat. Mus., Vol. 63, Art. 10, p. 2, 1923; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 156, 1924; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 83, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Antiplanes perversa Gabb, Dall, Bull. 112 U. S. Nat. Mus., p. 71, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 77, pl. 8, fig. 3, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925; Hertlein and Crickmay, Proc. Amer. Phil. Soc., Vol. 64, pp. 267, 271, 272, 274, 276, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 82, pl. 11, fig. 9, pl. 28, fig. 8, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Antiplanes catalinæ Raymond, Dall, Bull. 112 U. S. Nat. Mus., p. 71, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 83, 1927.

? *Pleurotoma sadoensis* Yokoyama, Journ. Fac. Sci., Imper. Univ. Tokyo., Sec. 2, Vol. 1, pt. 8, p. 259, pl. 32, fig. 3, 1926.

Pleurotoma contraria Yokoyama, Journ. Fac. Sci., Imper. Univ. Tokyo, Sec. 2, Vol. 1, pt. 9, p. 383, pl. 14, figs. 2*a*. 2*b*, 1926.

Shell of medium to large size, more often sinistral than dextral, spire elevated, of variable height, whorls eleven to twelve, flattened or rounded, smooth except for growth lines and on well-preserved specimens extremely fine spirals, protoconch of about two smooth, rounded, loosely coiled whorls; aperture varying around two-fifths length of shell, outer lip thin, with a deep, rounded notch a short distance below the suture, columella smooth, somewhat flexuous, of variable length, inner lip slightly resorbed; operculum with a terminal nucleus like that of typical *Spirotropis*.

Variety **perversa**, s. s.

Spire high, sutures not channeled, whorls rounded or flattened.

Dimensions of large living specimens: Altitude, 56 mm.; length of aperture, 21 mm.; diameter of body whorl, 15 mm.

Type specimens: Of *perversa*, at the University of California; of *thalea*, No. 122,568, of *santarosana*, No. 109,198, of *rotula*, No. 162,556, in the U. S. National Museum.

Type localities: Of *perversa*, post-Pliocene of San Pedro, Los Angeles County; of *catalinæ*, living off Catalina Island, Calif.; of *thalea*, off San Luis Obispo, Calif., in 252 fathoms; of *santarosana*, off Santa Rosa Island, Calif.; of *rotula*, Timms Point zone, "Pliocene" of Deadman Island, San Pedro, Los Angeles County.

U. Miocene: Empire formation of Oregon (Dall; Arnold and Hannibal; Howe); Montesano formation of Washington (Weaver).

M. Pliocene: ? Merced-Purisima formation of middle California (Martin).

U. Pliocene: Coos conglomerate of Oregon (Dall; Arnold and Hannibal; Howe); Wildcat series of northern California (Martin); Santa Barbara zone of Los Angeles (Moody); of Ventura Co. (Waterfall); of loc. 218 S. D. S. N. H., Sulphur Canyon east of South Mt., Ventura Co., seven specimens all sinistral (H. R. G.); loc. 223, O'Hare Canyon, Ventura Co., one specimen, dextral (H. R. G.); loc. 225, between Santa Paula Creek and Timber Canyon, Ventura Co., two sinistral and one dextral (H. R., G.); Japan (Yokoyama; Yabe ?).

Pleistocene: "Pliocene" of Deadman Island, Los Angeles Co., (Arnold); lower San Pedro of San Pedro and vicinity, common (Gabb; Arnold; Oldroyd); "Saugus" of Ventura Co. (Waterfall); "Pliocene" of Santa Monica, Rivers Collection (Buell); upper San Pedro of San Pedro and vicinity (Arnold).

Recent: Alaska to San Diego and the Cortez Bank (Dall, the same distribution given for several of the separately named forms).

The specimens of this species, which occur at some localities in large series, vary in direction of coiling, in inflation of the whorls, in relative height of spire, in relative length of the columella, etc. It seems foolish to try to separate the various combinations of these characters into distinct species, as Dall and others have tried to do; for the gradations from one form to another are complete in collections with large series of specimens, and the intermediates are more common than the extremes. The time has come when we have to abandon the old ideas of species as fixed forms, and accept a biologic interpretation, recognizing variation as an important natural fact.

The form described by Raymond as *catalinæ* was never figured, but the description allows little doubt that it is identical with the typical form originally described by Gabb. The form *contraria* (Yokoyama) is also sinistral and appears to fall well within the limits of variation of *perversa,* though the writers have not seen a specimen. All the other names cited in the synonymy are applied to dextral forms. It has already been explained above that the direction of coiling cannot always be accepted as a specific distinction, and the evidence in this case is practically conclusive that the forms coiled in opposite directions are not genetically separate. Miss Buell examined 600 sinistral specimens and 150 dextral specimens in the Rivers Collection and noted that the dextral specimens duplicate the forms of the sinstral, concluding that: "This duplication of dextral and sinistral forms minimizes the value of reversal of coil as a specific distinction in this group." The writers have also noticed this duplication in characters. The form named *smithi* by Arnold and later renamed *rotula* by Dall is like Gabb's type except that the coiling is dextral and the whorls more rounded. There are also sinistral round-whorled specimens and dextral flat-whorled specimens. Illustrations are here given of a naturally dextral specimen and of a sinistral specimen photographically reversed, to show how exactly they mirror each other. The form named *santarosana* (Dall) is like *rotula* except that it represents the high-spired extreme, with a slightly shorter columella such as is shown by many topotypes of *rotula,* and the spiral sculpture is better preserved. The form *thalæa* (Dall) is slightly shorter than *rotula,* with a form so like that of *santarosana* that Dall himself mixed up the illustrations of the two. The form *sadoensis* (Yokoyama) appears to be very much like *thalæa,* but it is poorly preserved and the synonymy is questioned.

Three varieties are recognized besides the typical; but the writers doubt that any of these varieties has any significance, except perhaps *fernandoensis* (English). If the first variety is of value, the name *voyi,* too long overlooked, should be used.

The range of this species is interesting. It appears in the upper Miocene of the north and is abundant in southern California only in the notoriously cold-water horizons of the upper Pliocene and the lower Pleistocene. It is not found in contemporaneous formations in the San Joaquin basin, either because the water was not cold enough or because it was not deep enough. The species, as living today, is characteristic of northern regions and comes southward only in deep water. The rare or questionable occurrences in the Merced-Purisima series, middle Pliocene of middle California, may represent deep-water specimens washed up from depths in the open ocean. The variety *fernandoensis* from the basal Pliocene of Elsmere Canyon is not very well known, and though similar in form may represent a warmer water adaptation. The occurrence in Elsmere Canyon is the only case known to the writers where the dextral and sinistral forms do not occur together in a given horizon or general region (the dextral forms in the upper Miocene are listed as *impecunia* Dall, see below); and although up to the present time too few specimens are known to base much of a conclusion on, the fact that this variety is the only one occurring in a warm-water horizon suggests that it alone among the varieties may be of significance.

Spirotropis (Antiplanes) perversa (Gabb) variety **voyi** (Gabb)

Pleurotoma voyi Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 7, pl. 1, fig. 11, 1866; Stewart, Proc. Acad. Nat. Sci., Phila., Vol. 78, p. 291, 1926.

Drillia voyi Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 73, 1868-9.

Pleurotoma vinosa Dall, Proc. Calif. Acad. Sci., Ser. 1, Vol. 5, p. 253, 1874; Keep, West American Shells, p. 158, fig. 142, 1904.

? Pleurotoma beringi Aurivillius, Vega Exp. Zool. Arb., Vol. 4, p. 354, pl. 13, fig. 3, 1885.
Pleurotoma (Antiplanes) vinosa Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 514, pl. 34, fig. 4, 1902.
Pleurotoma (Antiplanes) piona Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 514, 1902.
"*Pleurotoma perversa* Gabb," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 215, pl. 5, fig. 48, 1909.
"*Antiplanes thalæa* Dall," Dall, Proc. U. S. Nat. Mus., Vol. 56, pl. 11, fig. 6 (= *piona*), 1919.
Antiplanes kamchatica Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 33, pl. 10, 1919; Bull. 112 U. S. Nat. Mus., p. 71, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 83, 1927.
Antiplanes vinosa Dall, Bull. 112 U. S. Nat. Mus., p. 71, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 82, pl. 28, fig. 4, 1927.
? Antiplanes beringi Aurivillius, Dall, Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 87, 1927.
"*Antiplanes perversa* Gabb," Dall, Amer. Journ. Sci., Ser. 5, Vol. 3, p. 312, 1922.
Antiplanes piona Dall, Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 4, pl. 21, fig. 5, 1925.
Antiplanes yessoensis Dall, Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 4, pl. 21, fig. 3, 1925.

Shell like that of the typical variety but shorter, relatively fatter.

Dimensions (of Gabb's specimen, approximately): Altitude, 35 mm.; length of aperture, 16 mm.; diameter of body whorl, 13 mm.

Type specimens: Of *voyi*, probably lost (see Stewart); of *vinosa*, No. 122,575, of *piona*, No. 109,179, of *kamchatica*, No. 225,255, of *yessoensis*, No. 111,053, in the U. S. National Museum.

Type localities: Of *voyi*, upper Pliocene, Wildcat series of Humboldt Co., Calif.; of *vinosa*, Alaska; of *beringi*, Bering Sea (?); of *piona*, southwestern Bering Sea; of *kamchatica*, southeast coast of Kamchatka; of *yessoensis*, south coast of Yesso (Hokkaido).

U. Miocene: Quillayute fossils of Washington (Reagan).
U. or M. Pliocene: Wildcat series of Humboldt Co., northern California (Gabb).
Pleistocene: Lower San Pedro series of San Pedro and vicinity, a number of specimens in the Arnold Collection conforming to the characters of this variety.
Living: Alaska to San Diego and to Japan.

Gabb's type of this variety is plump, round-whorled, dextral, with a deep notch like that of *yessoensis*. The depth of the notch in this form, however, is variable on different whorls of the same individual; and the plumpness, roundness of whorls, and length of columella also vary as in the typical form, with which this variety intergrades. The sinistral form *vinosa* has an irregular, deformed appearance, and although short has a long columella. It is, however, outdone by a malformed, stunted individual from the San Pedro Pleistocene, and a number of others approach it. The form *beringi* appears to be like *piona*, but has less convex whorls; and *piona* is like typical *voyi* with a somewhat shallower notch. The form *kamchatica* is large and sinistral, but it does not reach the altitude of typical *perversa*. It has slightly rounded whorls and shows the spiral sculpture. The form *yessoensis* is like *voyi* except that the whorls are somewhat angulated. The variety *voyi* is not so common as the typical variety, except perhaps in Bering Sea, but it appears to have the same range and distribution. There are both dextral and sinistral forms for practically every shape.

Spirotropis (Antiplanes) perversa (Gabb) variety **pedroana** (Arnold)

Plate 26, Figures 24, 32

Pleurotoma (Leucosyrinx) pedroana Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 202, pl. 9, fig. 4, 1903.
Turris (Antiplanes) impeeunia Dall, Prof. Paper 59 U. S. Geol. Survey, p. 27, pl. 4, fig. 3, 1909.
Turris impeeunia Dall, Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 591, 1913; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93, 1922.
Antiplanes hyperia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 35, pl. 9, fig. 6, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 87, pl. 3, fig. 2, 1927.

Shell like that of the typical variety but with an excavated or channeled suture, small.
Dimensions (of Pleistocene specimen): Altitude, 19 mm.; length of aperture, 6.5 mm.; diameter of body whorl, 6.5 mm.

Type specimens: Of *pedroana*, No. 162,554, of *impecunia*, No. 153,912, of *hyperia*, No. 212,329*a*, in the U. S. National Museum.

Type localities: Of *pedroana*, lower San Pedro, Pleistocene, of Deadman Island, San Pedro, Los Angeles County; of *impecunia*, Empire formation, upper Miocene, of Coos Bay, Oregon; of *hyperia*, Drake's Bay, a little north of San Francisco, Calif., living.

U. Miocene: Type locality of *impecunia* (Dall; Arnold and Hannibal; Howe).
Pleistocene: Type locality of *pedroana* (Arnold).
Living: Drake's Bay to Coronado Islands (near Mexican boundary).

This variety has about the same range as typical *perversa* and *voyi*, but is rarer. It probably should not be separated from the typical *perversa*, for Dall expressly states that the channeled suture on his specimen is due to weathering, and it is most probable that the same is true of all the specimens. It may be obscuring the facts of nature to separate this variety artificially; but it is here kept for the sake of conservatism. All of the described forms are dextral; but there is a sinistral specimen in the Arnold Collection with channeled sutures.

Spirotropis (Antiplanes) perversa (Gabb) variety **fernandoensis** (English)

Plate 26, Figure 25

Turris fernandoensis English, Univ. Calif. Publ. Geol., Vol. 8, p. 217, pl. 23, fig. 7, 1914.

Shell like that of the typical variety, but with a relatively longer aperture, straighter columella, and biconical shape.
Dimensions (of figured specimen): Altitude (apex defective), 30 mm.; length of aperture, 15 mm.; diameter of body whorl, 12 mm.

Type specimen: At the University of California.

Type locality: Basal Pliocene of Elsmere Canyon, Los Angeles County.

L. Pliocene: Type locality (English); loc. 207 S. D. S. N. H., Elsmere Canyon, one specimen (H. R. G.).

The two specimens of this variety known to the writers are both dextral. It is the only variety of this species occurring with a warm-water fauna.

Spirotropis (Antiplanes) bulimoides (Dall)

Cf. Plate 26, Figure 26

Antiplanes bulimoides Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 34, pl. 11, fig. 7, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 4, pl. 31, fig. 2, 1925; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 86, 1927.

Shell of medium size, spire high, whorls smooth, nearly flat-sided, sutures not impressed, with the result that the spire as a whole has a blunted, slightly convex, torpedo-like outline; body whorl scarcely rounded in toward the straight columella, giving the aperture the shape of the aperture of a *Pseudomelatoma;* posterior notch, as indicated by the growth lines on the anal fasciole, rounded, not very deep, a short distance below the suture.
Dimensions (of Pliocene specimen): Altitude (apex defective), 30 mm.; length of aperture, 15 mm.; diameter of body whorl, 11 mm.

Type specimen: No. 111,051 in the U. S. National Museum.

Type locality: Living, Bowers Bank, Bering Sea.

? Pliocene: Basal Pliocene of loc. 207, S. D. S. N. H., Elsmere Canyon, Los Angeles Co., two specimens (H. R. G.); of loc. 216 S. D. S. N. H., east of Fernando Pass, Los Angeles Co., one specimen (H. R. G.).
Living: Type locality.

The lower Pliocene specimens agree so closely in shape, dimensions, and sculpture with the description and figure of this species that they are included here in spite of the peculiar range and distribution thus produced. This form may be but another peculiar variation of *S.* (*A.*) *perversa,* and if so its occurrences would be easily explained. Perhaps it is a form of *S. perversa* variety *fernandoensis,* though the convex outline of its spire and the very slight curvature of the body whorl give it quite a different appearance. It has the shape of a *Pseudomelatoma* with obsolete sculpture, which suggests a relationship with that genus. As in the variety *fernandoensis* of *perversa,* with which this occurs, all the specimens known are dextral.

Spirotropis (Antiplanes) lita (Dall)

Antiplanes litus Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 34, pl. 11, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 87, pl. 19, fig. 4, 1927.

Shell of small to medium size, spire fairly high, whorls moderately convex, smooth, posterior notch and anal fasciole very close to the suture.

Dimensions (from Dall): Height of shell, 16 mm.; of last whorl, 9 mm.; diameter, 5 mm.

Type specimen: No. 206,602 in the U. S. National Museum.

Type locality: Esteros Bay, California.

Living: Coast of Washington to Esteros Bay, California.

This species resembles a dextral *perversa* with elongate whorls but can be distinguished by the position of its notch and anal fasciole. It also resembles a smooth *Pseudomelatoma* and might possibly be classed with *Lævitectum.*

Spirotropis (Antiplanes) amphitrite (Dall)

Antiplanes amphitrite Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 37, pl. 9, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 88, 1927.

Shell small, short, round-whorled, practically smooth but with obscure nodulations on the shoulders of the spire whorls (about 15 on the last).

Dimensions (from Dall): Height of five whorls, 13.5 mm.; of last whorl, 10 mm.; diameter, 6 mm.

Type specimen: No. 209,953 in the U. S. National Museum.

Type locality: Santa Barbara Channel, California. Known only from there.

This species connects the subgenus with *Typhlomangelia.* The variety *beroë* Dall from San Diego (U. S. National Museum, specimen No. 21,466*a*), described under the same references as the typical variety but not figured, appears to be more like *lita.*

Genus PSEUDOMELATOMA Dall, 1918

Pseudomelatoma Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 317, 1918; Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, p. 205, 1925.

Type (by original designation), *Drillia penicillata* Carpenter; Pliocene to Recent, California.

Shell of medium size and weight, elongate, spire high; whorls of spire only very slightly convex, the lower four-fifths of each sculptured whorl ornamented with strong, slightly oblique ribs, the upper fifth separated into a narrow anal fasciole and an upper sculptured band on which is a single row of nodes, each node corresponding to a rib but somewhat offset in its position, ribs sometimes crossed by faint spirals; ornamentation on the body whorl often obsolete and sometimes on most of the spire as well; aperture about two-fifths the length of the shell, lenticular, outer lip thin, sharp, regularly curving, indented on the upper part by a small, shallow, triangular notch, which is separated from the suture only by the band of nodes, columella straight, smooth, canal not distinctly defined, short; operculum in living representatives small, horny, with a terminal nucleus.

Geologic range: Cretaceous to Recent; in California, Miocene to Recent.

Distribution: California and Lower California.

As in the case of *Perrona*, the relationship of this genus to *Clavatula* is easily traceable. In the course of evolutionary development, the spire has heightened, the columella has become shorter than that of the Cretaceous Clavatulas, the axial sculpture of *Clavatula* has remained, but the spiral has nearly faded out, and the notch, the anal fasciole, and the sculpture above the fasciole have remained but have been constricted so that the notch is smaller and closer to the suture. The Cretaceous *Clavatula amica* (Gardner) is a *Clavatula* which had in its time already developed nearly all of the generic characters of *Pseudomelatoma*. *P. pustulata* (Bronn), from the Miocene of Italy, is clearly congeneric, as can be seen by comparing it with the coarser-ribbed southern varieties of *P. penicillata*. In fossil specimens, *Pseudomelatoma* is apt to be confused with species of *Clavus* (*Cymatosyrinx*), for the latter often has whorls with much the same shape and with similar sculpture; but the aperture in the latter is much shorter, the outer lip is thickened and is cut off at both ends by a deep notch, the posterior notch being much stronger than in *Pseudomelatoma* and restricted on the columellar side by an horizontally elongate mound of shell material, the anterior notch being likewise well developed, whereas in *Pseudomelatoma* it is entirely lacking, and the columella is much shorter and somewhat twisted. The relationship is probably closer to *Moniliopsis;* but that genus is distinguished by its much finer sculpture and its shape, which is more like that of an elongate *Perrona*. *Melatoma* is also very similar, having the small notch high on the outer lip, the longitudinal costæ and often a row of nodes above the anal fasciole as well as below; but the South African species assigned to *Melatoma* are distinguished by their shorter, truncated columellas, more quadrate apertures, which expand anteriorly, and (perhaps because of the more nearly equidimensional apertures) by opercula with the nuclei on the inner side.

Pseudomelatoma penicillata is a variable species, being connected by its variety *moesta* and other intermediate forms with *P. torosa* (Carpenter). *P. torosa* sometimes has a remnant of the band above the anal fasciole, but in most cases this band is entirely absent, which means that the fasciole and the posterior notch have become adjacent to the suture. At the same time, the longitudinal ribs or costæ have contracted to only slightly elongate nodes. The result is that *torosa* approaches very closely in general appearance and in generic characters the species of *Turricula* with short anterior canals like *T. maculosa* (Sowerby). The last mentioned species is, however, recognized as a *Turricula* by its larger, rounded notch close to the suture, by its sharper angle, and by its smaller nodes confined to the angle, as well as by its normally longer columella. On the other hand, *P. torosa* resembles closely *Clavus unimaculatus* and its allies, but can be distinguished by its broader anal fasciole and its more slender columella with no defined inner lip and no callus pile under the suture, and also by its generally longer columella. The separation between *P. torosa* and *T. maculosa* is perhaps harder to make than that between any other two branches of the family, except those that are here described as directly derived one from the other; but it is confirmed by the opercula and radulæ and by the characters of the more typical specific relatives of each. The *Pseudomelatoma* group is considered a descendant of *Clavatula* intermediate in character between *Turricula* and *Clavus*.

Subgenus **PSEUDOMELATOMA**, s. s.

Shell generally showing sculpture on most of the whorls of the spire.

Pseudomelatoma penicillata (Carpenter)

Plate 26, Figures *5a*, *5b*, 18

Drillia penicillata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 658, 665, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 144, 151 (bottom pagination), 1872; Journ. de Conchyl., Vol. 12 (Ser. 3, Vol. 5), p. 146, April, 1865, reprinted in Smithsonian Misc. Coll., No. 252, pt. M, p. 314 (bottom pagination), 1872.

Not "*Drillia penicillata* Carpenter," Tryon, Man. Conch., Vol. 6, p. 182, pl. 12, fig. 40, 1884; Keep, West Coast Shells, p. 56, fig. 38, 1888; West American Shells, p. 159, fig. 144, 1904.

Not *Drillia inermis* var. "*penicillata* Carpenter," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 205, 1903.

Pseudomelatoma penicillata Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 21, pl. 22, fig. 3, 1919.

Shell of medium size and thickness; sculpture on the whorls of the spire consisting of 11 to 16 long, sharp, slightly oblique, longitudinal costæ, with a corresponding subsutural band of low, rounded nodes, sculpture on the body whorl of the adult practically obsolete; aperture lenticular, notch shallow and situated high on the outer lip, canal indistinctly defined, of moderate width, columella fairly long, slender, simple; operculum horny, with a terminal nucleus.

Dimensions: Altitude, 37 mm.; length of aperture, 15 mm.; diameter of body whorl ,13 mm.The largest specimen examined had an altitude of about 45 mm. and a heavier shell.

Type specimen: In the U. S. National Museum.

Type locality: Cedros Island, Lower California.

It is unfortunate that there should be considerable uncertainty about the identity of of this species, which Dall selected as the type of the genus. Carpenter's first description is very brief:

> "375 *Drillia penicillata*, n. s. Like *inermis*, with delicate brownish pencillings."

Pleurotoma inermis Hinds, 1844, not of Partsch, (1842) 1843, is now known as *Moniliopsis incisa* (Carpenter) var. *ophioderma* (Dall), and hence if we had nothing but Carpenter's original description to go by we should necessarily consider *penicillata* a form of *Moniliopsis*. Weinkauff, Tryon, Keep, Arnold, and others have identified *penicillata* as a shell belonging to the group now called *Moniliopsis*, and Carpenter in his more detailed description in the Journal de Conchyliologie expresses himself in such a way as to suggest this interpretation. The following is a translation of Carpenter's description:

> *Drillia*, shell in form and in nature like that of *Drillia inermis;* but ashy, with close-set, dark reddish-brown pencillings; with very numerous little lines, sometimes diagonal, sometimes zigzagged or interrupted in various ways; whorls flattened, with plications or costæ, about 14 in number, interrupted in the region of the very small, wide, dilating sinus, nodose posteriorly; canal broad. Length, 1.35; length of spire, .75; width, .42 inches; angle, 25°.
>
> Habitat: Cedros Island, Lower California.
>
> All the individuals that I have seen of this species were excessively worn; but it can be recognized very easily by its elegant coloration.

Moniliopsis incisa ophioderma has very characteristically the many little dark reddish-brown pencilled growth lines, bent into chevron-shaped zigzags as they pass over the slit band; but the *Pseudomelatoma* identified as *penicillata* by Dall does not appear to have any character corresponding to this feature, which was so strongly emphasized by Carpenter in his name and description. On the other hand, the *Moniliopsis* has no axial sculpture which should be described as costæ, and only by an exceptional stretch of the imagination could the unusually sparse, pencilled growth lines on the shell figured by Weinkauff and Tryon be considered costæ. Furthermore, there are no nodes on the *Moniliopsis* which would cause Carpenter to describe the costæ as nodose posteriorly. Carpenter's type was evidently badly beach-worn; and as *Moniliopsis* and *Pseudomela-*

toma are closely related genera, it would not be surprising to find that erosion on a specimen of the latter would bring out the growth-line markings characteristic of the former. The *Pseudomelatoma* is a stouter shell and would be much more likely to survive in a beach-worn condition than the comparatively delicate *ophioderma*. Hence, as Dall probably had access to Carpenter's type when he was selecting a new specimen to figure as *penicillata*, although he did not expressly mention having examined the type, Dall's identification is here tentatively accepted, in spite of the opinions of earlier writers, as a solution of the problem caused by Carpenter's ambiguous description. It is to be hoped that this interpretation is correct, for the alternative interpretation would, if true, invalidate the name *Pseudomelatoma*.

The older fossil records of this species cannot be relied upon, for they apply to *Moniliopsis incisa ophioderma;* but it is probable that the typical form occurs in beds at least as old as those in which the variety *moesta* is recorded. The Miocene fossil recorded under *penicillata* is intermediate between that form and *torosa*, and for this reason was at first identified as *moesta*.

Variety **penicillata**, s. s.

Shell of moderate weight and size, costæ strong on the whorls of the spire, but on the body whorl of the adult usually obsolete. Lagoon forms with larger, heavier shells and rounded costæ.

U. Miocene: Santa Margarita formation, from a depth of 5241 feet in the Pacific Eastern Production Company's well KCL-B No. 1, Sec. 21, T. 29 S., R. 27 E., near Bakersfield (H. R. G.).
Living: West coast of Lower California; Cedros Island; and Gulf of California.

Pseudomelatoma penicillata (Carpenter) variety **moesta** (Carpenter)

Drillia moesta Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 537, 657, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 23, 143 (bottom pagination), 1872; Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 181, 1865, reprinted in Smithsonian Misc. Coll., No. 252, pt. K, p. 283 (bottom pagination), 1872; Tryon, Man. Conch., Vol. 6, p. 183, pl. 12, fig. 38, 1884; Keep, West Coast Shells, p. 56, fig. 39, 1888, 1892; West American shells, p. 159, fig. 145, 1904.

Pleurotoma (*Drillia*) *moesta* Carpenter, Weinkauff, Syst. Conchyl. Cab., Pt. 238, p. 134, pl. 30, figs. 5, 8, 1876.

Pseudomelatoma moesta Carpenter, Dall, Bull. 112 U. S. Nat. Mus., p. 70, 1921; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 75, 1927.

Shell like that of the typical variety, but slightly smaller and with a tendency for the sculpture to become obsolete earlier.
Dimensions: Altitude, 26 mm.; length of aperture, 11 mm.; diameter of body whorl, 8.5 mm.

Type specimen: In the British Museum.

Type locality: Santa Barbara.

Upper Pleistocene: Of San Quintin Bay, Lower California (Jordan).
Living: Monterey, California to Cedros Island, Lower California (Dall).

This is a more northern variety, clearly belonging to the same species as the typical variety. Carpenter's description of this form fits the typical variety much better than does his description of *penicillata*, a further reason for questioning Dall's interpretation of the latter name.

Pseudomelatoma penicillata (Carpenter) variety **semiinflata**, new variety

Plate 26, Figure 19

Shell like that of the typical variety but narrower, the whorls less convex, the ribs about 16 on the penultimate whorl, low and nearly straight, the inner lip defined by a thick callus.
Dimensions: Altitude, 34 mm.; length of aperture, 14 mm.; diameter of body whorl, 11 mm.

Type specimen: No. 237 in the collection of the San Diego Society of Natural History.

Pleistocene: Of Santa Monica.

This variety has stronger sculpture than *moesta*. It has more numerous, less oblique ribs than *fleenerensis*, and the whorls are less inflated. Erosion may have emphasized the inner lip, as in *fleenerensis*.

Pseudomelatoma torosa (Carpenter)

Plate 26, Figure 20

Drillia torasa Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 657, 1864, reprinted in Smithsonian Misc. Coll., No. 252, p. 143 (bottom pagination), 1872; Journ. de Conchyl., Vol. 12 (Ser. 3, Vol. 5), p. 145, 1865, reprinted in Smithsonian Misc. Coll., No. 252, pt. M, p. 313 (bottom pagination), 1872; Tryon, Man. Conch., Vol. 6, p. 183, pl. 14, fig. 93, 1884; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 239, 1888; Keep, West Coast Shells, p. 56, not fig. 59, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 209, 1903; Keep, West American Shells, p. 159, not fig. 145, 1904.

Pseudomelatoma torosa Carpenter, Dall, Bull. 112 U. S. Nat. Mus., p. 70, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. I, p. 76, 1927.

Shell of moderate weight and about the size and shape of *moesta* (Carpenter), related to *penicillata* but with the costæ reduced to large, somewhat elongate nodes, about 8 in number, subsutural band much reduced and sometimes absent, whorls sometimes crossed by faint spiral lines, nodes often weak on the body whorl; operculum with a terminal nucleus.

Dimensions: Altitude, 31 mm.; length of aperture, 12 mm.; diameter of body whorl, 12 mm.

Type specimen: In the British Museum.

Type locality: Monterey Bay.

This form grades southward into *P. penicillata* and its variety *moesta*, and it should perhaps be considered another, still more northern, variety of that species. It is treated separately here because the strong node-like costæ and the weak subsutural band give it such a strikingly different appearance. It looks so much like *Turricula maculosa* that the writers were for a while tempted to transfer it to *Turricula*, but it has a still shorter aperture and a much smaller, v-shaped notch.

Variety **torosa**, s. s.

Shell with the subsutural band obsolete.

Pleistocene: "Pliocene" of San Pedro (Arnold); Santa Barbara (Cooper); San Pedro (Arnold).
Living: Monterey, California, to Scammons Lagoon, Lower California (Dall).

Pseudomelatoma torosa (Carpenter) variety **aurantia** (Carpenter)

Drillia (? *torosa* var.) *aurantia* Carpenter, same citations as for *torosa, s. s.*

Pseudomelatoma torosa aurantia Carpenter, Dall, Oldroyd, same citations as for *torosa, s. s.*

Pseudomelatoma torosa somisensis Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 86, pl. 6, figs. 2, 3, 1929.

Shell with the subsutural band distinct, nodes sometimes somewhat elongated, more like the costæ of *penicillata*.

Dimensions (from Carpenter): Length, .6 inch.; length of spire, .32 inch; width, .28 inch; angle, 38°.

Type specimens: Of *aurantia*, in the U. S. National Museum; of *somisensis*, at the University of California.

Type localities: Of *aurantia*, San Diego, living; of *somisensis*, lower Pleistocene of Ventura County.

Pleistocene: Type locality of *somisensis*.
Living: Monterey to Mazatlan, Mexico (Oldroyd).

This variety is probably hardly worth distinguishing, but is kept to emphasize the fact that the subsutural band is sometimes distinct in this species, helping to show the relationship with the more southerly *P. penicillata*. It will be noticed that this variety, which is more closely related to *penicillata*, has a more southerly distribution than has the typical variety.

Pseudomelatoma fleenerensis (Martin)

Drillia fleenerensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 193, pl. 22, fig. 5, 1914.

Shell of medium or small size, sculptured with about 14 elongate, slightly oblique costæ, like *P. penicillata* except that the anal fasciole lies directly below the suture and the subsutural band of nodes is obsolete as in *P. torosa, s. s.*, and also, the outline of the whorls is more rounded than in *penicillata*, and the inner lip appears to be better defined.

Dimensions (from Martin): Altitude of the type, apex defective, 31 mm.; maximum diameter of the shell, 10.5 mm.; length of the aperture, 9.5 mm.; length of the canal, 3 mm.; apical angle, 25°.

Type specimen: At the University of California.

Type locality: Upper part of the Wildcat series, one mile south of Centerville, Humboldt Co. (U. C. loc. 1860).

Upper Pliocene: Uncommon, known only from the type locality (Martin).

It is not unlikely that this form is just another one of the connecting links between *P. penicillata* and *P. torosa*. On the other hand, the curvature of the whorls makes it more the shape of the form *merriami* of *Borsonia bartschi* (Arnold), which is distinguished merely by its deeper notch close to the suture and its short node-like costæ. If the possibility of variation in *fleenerensis* be recognized as in the *penicillata-torosa* series, it can be seen that *fleenerensis* might be another variety of *bartschi;* and this possibility helps to show, as mentioned above, how difficult it is to separate *Pseudomelatoma* from the various genera to which it is closely related. Martin compared *fleenerensis* with *Clavus* (*Cymatosyrinx*) *johnsoni* Arnold, but the shape of the aperture and the armed notch of the latter (poorly shown in Arnold's figure), as well as the sculpture, indicate that the two species are only distantly related.

Subgenus **LAEVITECTUM** Dall, 1919

Lævitectum Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 19, 1919.

Type (by monotypy), *Drillia eburnea* Carpenter.

Shell like that of typical *Pseudomelatoma*, but with sculpture only on the earliest whorls, or entirely lacking.

This subgenus or section is distinguished from *Spirotropis* by its smaller notch, closer to the suture, and perhaps also by a heavier shell.

Spirotropis (*Antiplanes*) *lita* (Dall) and *S.* (*A.*) *bulimoides* (Dall) are forms showing the connection between this group and *Antiplanes*, and it is possible that the former would be more appropriately classified here.

Pseudomelatoma (Lævitectum) eburnea (Carpenter)

Not *Pleurotoma eburnea* Bonelli, 1842.

Drillia eburnea Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 668, 1864, reprinted in Smithsonian Misc. Coll., No. 252, p. 154 (bottom pagination), 1872; Proc. Zool. Soc. London, p. 280, 1865, reprinted in Smithsonian Misc. Coll., No. 252, pt. I, p. 273 (bottom pagination), 1872.

"? *Clathrodrillia*" (*Læviteetum*) *eburnea* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 19, pl. 13, fig. 5, 1919.

Shell like the coarser, thicker shelled variations of *Pseudomelatoma penicillata*, but with sculpture consisting of axial ribs, on only one or two of the earliest whorls of the spire.

Dimensions (from Carpenter): Length, 1.3 in.; length of spire, .8 in.; width, .45 in.; angle, 30°.

Type specimen: No. 22,817 in the U. S. National Museum.

Type locality: ? Gulf of California.

This species is very interesting, showing the relation between these smooth forms and the more sculptured Pseudomelatomas. It may be only an unusually smooth specimen of *penicillata*, for a number of forms of *penicillata* have several of the whorls of the spire, as well as the body whorl, smooth.

Genus MELATOMA Swainson, 1840

Melatoma Swainson, Treat. Malac., pp. 202, 342, 1840; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 317, 1918.

? *Clionella* Gray, Proc. Zool. Soc. London, p. 153, 1847, type (by original designation) *Buccinum sinuatum* Born, 1778, illustrated by Chemnitz, Neues Syst. Conchyl. Cab., Vol. 4, p. 307, pl. 155, fig. 1464, 1780, under the name *Boletus turbinatus*, the figure being referred to by Born in the Test. Mus. Cæs. Vind., p. 268, 1780, also figured by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 8, species 68, as *buccinoides* Lamarck, and by Tryon, Man. Conch., Vol. 6, p. 233, pl. 9, fig. 50, 1884, living, South Africa; Iredale, Proc. Malac. Soc. London, Vol. 13, p. 32, 1918.

Type (by monotypy), *M. costata* Swainson, Treat. Malac., p. 342, fig. 104, 1840, said by Swainson on the authority of Rafinesque to have been collected in the Ohio River, but Dall thinks otherwise.

Distribution: South Africa (?).

Swainson's figure resembles *Pseudomelatoma penicillata* var. *moesta* more than it does *Clionella sinuata* (Born), so it is to be wondered on what evidence Dall based his identification of *Melatoma* with *Clionella*. Perhaps Iredale is right in advising the use of *Clionella* for the South African group.

Clionella has a short, almost *Terebra*-like aperture, with a deeply notched, very short, undefined anterior canal. *Melatoma costata* Swainson has an elongate aperture, fully half as long as the shell, and the anterior canal is not notched. The sculpture of both is like that of *Pseudomelatoma penicillata*. Among the species assigned to *Clionella* by Tryon is *Pleurotoma sigillata* Reeve from South Africa, which is so much like *Moniliopsis graciosana* (Arnold) that it is somewhat of a question whether the latter should not be assigned to *Clionella*, perhaps with *Moniliopsis* as a subgenus.

Genus MONILIOPSIS Conrad, 1865

Moniliopsis Conrad, Amer. Journ. Conch., Vol. 1, p. 143, 1865; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 317, 1918.

Type (by monotypy), *Pleurotoma elaborata* Conrad, Fos. Sh. Tert. Form., Ed. 1, no. 4, p. 46, October, 1833; Ed. 2, no. 3, p. 52, pl. 17, fig. 19, 1835, republished by G. D. Harris, Washington, 1893; Eocene, Claiborne, Alabama.

Shell of medium size, of medium weight or thin, spire high; protoconch smooth, of about two whorls, the rest of the shell sculptured with finely incised spiral lines about equal in prominence to the elevated growth lines which zigzag across the anal fasciole and gently curve over the lower part of the body whorl, growth lines about half as wide as their interspaces; aperture lenticular, approximately a third the length of the shell, outer lip thin, smoothly curving, with a shallow triangular notch about a quarter of the way down from the suture, inner lip defined as the area on which the sculpture of the body whorl has been resorbed, body whorl curving in abruptly near the middle of the columella, columella varying in length, sometimes nearly straight, sometimes moderately twisted, in the latter case a short anterior canal often distinctly defined by the bending in of the outer lip, anterior canal with a broad, shallow notch behind; operculum horny, with a terminal nucleus.

Geologic range: Eocene to Recent.

Distribution: Puget Sound to Lower California.

This genus is very closely allied to *Pseudomelatoma,* with which it intergrades, and the latter might well be considered a subgenus. *Pseudomelaloma* is distinguished by its heavier shell, its stronger axial sculpture, and its straight columella. Apparently the more recently named *Clathrodrillia,* with which Dall classed *Moniliopsis* and which is here considered a subgenus of *Clavus,* is only distantly related, being shown by its armored aperture to belong to the *Clavus* branch of the family.

The figure of the type species of *Moniliopsis* is, as Dall remarks, very poor, and apparently it does not show the full view of the aperture. A small living specimen of *M. incisa,* if turned slightly to the right, resembles very closely Conrad's type figure, except that the columella on the latter is shorter and the sculpture is inadequately represented.

Moniliopsis grippi Dall

Moniliapsis grippi Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 27, pl. 8, fig. 2, 1919.

Clathrodrillia (*Moniliopsis*) *grippi* Dall, Bull. 112 U. S. Nat. Mus., p. 69, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 72, pl. 11, fig. 15, 1927.

Shell having the shape of *Pseudomelatoma,* though smaller and more delicate; early whorls sculptured with 14 or 15 strong, rounded ribs and a corresponding row of nodes above the anal fasciole as in *Pseudomelatoma, s. s.,* all whorls sculptured with revolving incised lines as in *Moniliopsis incisa,* the lines passing over the ribs of the early whorls; columella straight, aperture broad, rounding anteriorly as in *Pseudomelatoma,* anterior canal not defined.

Dimensions: Altitude, 27 mm.; altitude of last whorl, 16 mm.; diameter, 10 mm.

Type specimen: No. 203,670 in the U. S. National Museum.

Type locality: San Diego, California, living, known only from the type locality.

This species is very interesting, for it bridges the gap between *Moniliopsis* and *Pseudomelatoma.* The strength of the spiral sculpture and the more delicate construction of the shell place it here rather than in *Pseudomelatoma. Lora levidensis* (Carpenter) resembles this species except that it lacks the nodes above the anal fasciole, and the columella and outline of the body whorl are more flexuous. The operculum of *levidensis* has a terminal nucleus, as is normal for *Moniliopsis,* and if it should ever be found that that species belongs to *Moniliopsis, grippi* might be a variety of it. *Moniliopsis grippi* should not be confused with Dall's "*Lora*" *grippi,* which is probably a *Bellaspira.*

Moniliopsis incisa (Carpenter)

Plate 26, Figure 21

Drillia incisa Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 603, 657, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 89, 143 (bottom pagination), 1872; Proc. Acad. Nat. Sci., Phila., p. 62, 1865; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 239, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 205, 1903; Keep, West American Shells, p. 160, 1904.

Drillia cancellata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 603, 658, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 89, 144 (bottom pagination), 1872; Proc. Acad. Nat. Sci., Phila., p. 63, 1865; Tryon, Man. Conch., Vol. 6, p. 183, 1884; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 204, 1903; not *Drillia cancellata* J. Sowerby, 1827, etc.

Turris (*Surcula*) *rhines* Dall, new name for *Drillia cancellata* Carpenter, Proc. U. S. Nat. Mus., Vol. 34, p. 248, 1908.
Moniliopsis rhines Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 28, pl. 8, fig. 5, 1919 (young).
Moniliopsis incisa Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 28, pl. 12, fig. 7, 1919.
Turris incisa Carpenter, Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 342, pl. 41, figs. 2*a*, 2*b*, 1918.
Clathrodrillia (*Moniliopsis*) *incisa* Carpenter, Dall, Bull. 112 U. S. Nat. Mus., p. 70, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 75, pl. 18, fig. 3 (4 on plate), 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 72, pl. 18, fig. 3, 1927.
Clathrodrillia (*Moniliopsis*) *rhines* Dall, Bull. 112 U. S. Nat. Mus., p. 70, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 76, pl. 5, fig. 4, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 74, 1927.

Shell conforming closely to the generic description, of eleven or twelve whorls when adult, each whorl with 20 to 25 spiral, incised lines, about half as wide as the flat-topped interspaces and with 30 to 40 raised growth lines of varying strength of development.

Variety **incisa**, s. s.

Shell of moderate size and weight, with comparatively strongly convex, evenly rounded whorls and a fairly short columella, with the minimum number of spiral grooves and, except on the young or on unusually well-preserved specimens, almost indistinguishable growth lines.

Dimensions: Altitude, 25 mm.; length of aperture, 11 mm.; diameter, 8 mm.

Type specimens: At the Academy of Natural Sciences, Philadelphia ?.

Type locality (for both names): Puget Sound.

Pleistocene: "Saugus," lower San Pedro series, Las Posas formation, of loc. 233 north of Arroyo Santa Rosa, Ventura Co., six specimens (U. S. G.); loc. 247 north of city of Ventura, Ventura Co., one specimen (U. S. G.); loc. 249 north of city of Ventura, Ventura Co., five specimens (U. S. G.); Santa Barbara (Cooper); San Pedro, upper and lower horizons (Arnold); San Diego (Arnold); upper San Pedro of Santa Monica.

Living: British Columbia, Puget Sound, and an undetermined distance southward, probably not so far as it is commonly reported (San Pedro or San Diego).

The typical variety of this species is characteristic of the northern part of the range. The shells are usually heavier and have a rougher surface than the more southerly varieties, and only on young specimens like those known under the name of *rhines* does the delicate cancellate sculpture typical of *Moniliopsis* appear. The northern specimens assigned to *M. halcyonis* by Dall and Oldroyd probably also belong here.

Moniliopsis incisa (Carpenter) variety **ophioderma** (Dall)

Pleurotoma inermis Hinds, Proc. Zool. Soc. London, p. 37, 1843; Zool. Voy. *Sulphur*, Mollusca, p. 16, pl. 5, fig. 8, 1844; not *Pleurotoma inermis* Partsch, (1842) 1843.
Drillia inermis Hinds, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 330, 1857; Rept. for 1863, pp. 537, 541, 584, 657, 683, 1864, reprinted in Smithsonian Misc. Coll., No. 252, 1872; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 72, 1868-9; Tryon, Man. Conch., Vol. 6, p. 182, pl. 12, figs. 40, 43, pl. 32, fig. 42, 1884; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 239, 1888.
Pleurotoma (*Clionella ?*) "*penicillata* Carpenter," Weinkauff, Syst. Conch. Cab., Pt. 238, p. 125, pl. 28, figs. 1, 4, 1876.
"*Drillia penicillata* Carpenter," Tryon, Man. Conch., Vol. 6, p. 182, pl. 12, fig. 40, 1884; Keep, West Coast Shells, p. 56, fig. 38, 1888; West American Shells, p. 159, fig. 144, 1904.
Not "*Drillia inermis* Hinds," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 205, pl. 5, fig. 10, 1903, = variety *fancheræ* Dall.
Drillia inermis "var. *penicillata* Carpenter," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 205, 1903.
Turris (*Surcula*) *ophioderma* Dall, new name for *Pleurotoma inermis* Hinds, Proc. U. S. Nat. Mus., Vol. 34, p. 247, 1908.
Moniliopsis ophioderma Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 28, pl. 12, fig. 5, 1919.
Clathrodrillia (*Moniliopsis*) *incisa ophioderma* Dall, Bull. 112 U. S. Nat. Mus., p. 70, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 73, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.
Clathrodrillia ophioderma Dall, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.
Not *Moniliopsis incisa* "*ophioderma* Dall," Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925.
Clathrodrillia incisa ophioderma Dall, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Like the typical variety, but with slightly larger, thinner shell, with somewhat more flattened, elongate whorls, with weaker spiral grooves but stronger axial sculpture, and with reddish-brown color markings instead of greenish-gray.

Dimensions: Altitude, 47 mm.; length of aperture, 18 mm.; diameter, 13 mm.

Type specimen: Whereabouts unknown.

Type locality: Unknown.

Pleistocene: Upper and lower San Pedro of San Pedro, etc., San Diego, and Ventura (Arnold); Magdalena Bay and San Quintin Bay, Lower California (Jordan); "Saugus" of Ventura Co. (Waterfall).

Living: Bolinas Bay, California, to Ballenas Lagoon, Lower California (Dall). Carpenter reports *D. inermis* or a related species living in Japan, but no later record of such an occurrence has been found.

The variety *ophioderma* is the common form in California. It is distinguished from the variety *fancheræ* by the more flattened outline of the whorls. In *fancheræ* the whorls are strongly convex in the middle, abruptly contracted below, and often slightly concave above, whereas in *ophioderma* the whorls are nearly flat in the middle and are full above the fasciole, recalling in some respects the typical form of *Perrona.* The height of the spire varies considerably.

Moniliopsis incisa (Carpenter) variety **fancheræ** (Dall)

"*Drillia inermis* Hinds," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 205, pl. 5, fig. 10, 1903.
Mangilia fancheræ Dall, Proc. Biol. Soc. Wash., Vol. 16, p. 172, 1903.
Turris (*Surcula*) *halcyonis* Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 248, 1908.
"*Turris* (*Drillia*) *inermis* (?) Hinds," Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, 1916.
Turris (*Drillia*) *modestus* Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 54, pl. 1, fig. 8, 1916.
Moniliopsis fancheræ Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 28, pl. 8, fig. 3, 1919.
Moniliopsis halcyonis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 29, pl. 8, fig. 1, 1919.
Clathrodrillia (*Moniliopsis*) *fancheræ* Dall, Bull. 112 U. S. Nat. Mus., p. 70 (pl. 6, fig. 3 ?), 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 74, pl. 19, fig. 8 (pl. 3, fig. 4 ?), 1927.
Clathrodrillia (*Moniliopsis*) *halcyonis* Dall, Bull. 112 U. S. Nat. Mus., p. 70, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 76, pl. 18, fig. 1, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 73, pl. 7, fig. 2, pl. 18, fig. 1 (same figure), 1927.
Borsonella polynotata Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 158, 1924, unnecessary new name for *modestus.*
Moniliopsis incisa "*ophioderma* Dall," Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925.

Shell like that of the typical variety but with more strongly convex whorls curving in abruptly below the middle and making the columella more slender, the upper part of the whorls often slightly concave, the sculpture stronger and more distinct, the color dark brownish.

Dimensions: Altitude, 23 mm.; length of aperture, 10 mm.; diameter, 7 mm.

Type specimens: Of *fancheræ*, No. 109,303, of *halcyonis*, No. 110,644, in the U. S. National Museum; of *modesta-polynotata*, at the University of California.

Type localities: Of *fancheræ*, near Avalon, Catalina Island; of *halcyonis*, Coronado Beach, San Diego; of *modesta-polynotata*, upper Pliocene, Fourth and Broadway, Los Angeles.

U. Pliocene: Fourth and Broadway, Los Angeles (Moody).

Pleistocene: Upper San Pedro of San Pedro (Arnold; Oldroyd, 1925).

Living: Santa Rosa Island, California, to Point Abreojos, Lower California (Dall). The northern reports of *halcyonis* appear to be erroneous.

The varieties of *incisa* seem to have an ecologic significance, but they grade into each other so completely that they probably belong to the same specific stock. Just as *rhines* is probably the young of *incisa, s. s.*, so *fancheræ* is probably the young of *halcyonis.* If further study should show that *halcyonis* is separable from *fancheræ*, the references to the latter should include only those in which the name *fancheræ* was used, and only part of those. Some young *halcyonis* have surely been mixed in, and the second shell illustrated by Dall as *fancheræ* may not belong even to the genus. The size, height of spire, and strength of sculpture vary in this variety as in the others.

Moniliopsis incisa (Carpenter) variety **quinquecincta,** new variety

Plate 26, Figure 33

Shell of relatively small size, moderately solid, of five whorls plus probably three or four more in the apex, which is missing on the type, high-spired; whorls evenly convex, body whorl curving in abruptly below the middle as in the variety *fancheræ,* spire whorls sculptured with about five strong, squarish, revolving cords, about half as wide as the interspaces, body whorl with seven or eight more, equally strong, similarly spaced cords, growth lines crossing the cords as in *fancheræ* but weaker and obscured in the type specimen by weathering; columella shorter than in *fancheræ* and somewhat twisted, though defective; aperture also shorter and without a well-defined anterior canal.

Dimensions: Altitude (apex missing), 20 mm.; length of aperture, 7 mm.; diameter, 6 mm.

Type specimen: No. 247 in the collection of the San Diego Society of Natural History.

Type locality: Basal Pliocene of Elsmere Canyon, Los Angeles County.

Pliocene: Known only from the type locality, loc. 207 S. D. S. N. H., Elsmere Canyon, Los Angeles County, one specimen (H. R. G.).

The shape and the size of this variety recall the variety *fancheræ* except for the columella and the shorter aperture. The predominance of the spiral sculpture recalls the variety *incisa, s. s.,* but the relative width of cords and grooves is reversed and the cords are fewer in number. This variety may be, or may represent, the ancestor of the others.

This form is similar to *Asthenotoma* (*Endiatoma*) *quadricincta* (Cossmann), but lacks the columellar plait mentioned by Cossmann in his description.[1] It is not unlikely that *Endiatoma* should be considered a subgenus of *Moniliopsis.*

Moniliopsis briseis (Dall)

? *Turris* (*Antiplanes*) *diaulax* Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 247, 1908.

Antiplanes briseis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 35, pl. 32, fig. 1, 1919; Bull. 112 U. S. Nat. Mus., p. 72, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 85, 1927.

? *Antiplanes diaulax* Dall, Bull. 112 U. S. Nat. Mus., p. 71, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 84, 1927.

Shell like that of *M. incisa* variety *fancheræ* but with the sculpture nearly obsolete.

Type specimens: Of *diaulax,* No. 110,609, of *briseis,* No. 212,329, in the U. S. National Museum.

Type locality: Coronado Islands, near Mexican boundary, known only from the type locality.

This species (or it may be another variety of *incisa*) is interesting because it bridges the gap between *Moniliopsis* and *Spirotropis* and helps to illustrate how closely the two groups are related. It still retains enough of the sculpture so that it is more appropriately placed in *Moniliopsis.* The form *diaulax* has never been figured, but from the description it appears to be the same. If it is, the name *diaulax* should be used instead of *briseis.* The types come from the same place.

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[1] Ess. Paléo. Comp., Vol. 2, p. 106, pl. 6, fig. 30, 1896.

Moniliopsis graciosana (Arnold)

Plate 26, Figures 12, 13

Drillia graciosana Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 12, pl. 54, fig. 18, 1907, figure reprinted in Bull. 322 U. S. Geol. Survey, pl. 21, fig. 18, 1907.

Shell of medium size, of variable weight, spire elevated; whorls angulated a little above the middle of the spire whorls, concave above, convex below, sculptured with axial riblets, 17 to 19 to a whorl, fairly strong and sloping obliquely forward on the periphery, weaker and sloping obliquely backward above the angle, more or less obscure on the body whorl, and not extending below the peripheral band, spiral grooves crossing the riblets, one to three above the angle, strong, equal to or narrower than the intervening bands, one or two very faint on the periphery, usually visible on the spire whorls only, and nine to eleven below the peripheral band on the body whorl, strong, usually much narrower than the intervening bands but sometimes of approximately equal width, only one or two showing on the spire whorls; aperture about two-fifths the length of the shell, ovate, outer lip simple, with a moderately deep, rounded notch on the periphery, inner lip usually more or less strongly incrusted, but sometimes partly resorbed, columella short, twisted, anterior canal short, with a shallow notch behind, sometimes leaving a well-marked siphonal fasciole.

Dimensions (of figured specimen): Altitude, 28 mm.; latitude, 12 mm.; length of aperture, 12 mm.

Type specimen: In the U. S. National Museum.

Type locality: Pliocene of Graciosa Ridge, Santa Barbara Co.

This species is distinguished from *M. incisa* (Carpenter), which has a similar notch, similar general shape, and similarly incised grooves, by its somewhat more stumpy form and its axial riblets. It is distinguished from *Turris cingulifera* (Lamarck), to which it bears a remarkable resemblance, by its shallower notch, its shorter spire, and its axial riblets. It helps to link *Moniliopsis* with *Turris* and *Hemipleurotoma.* It is also similar in appearance to *Pleurotoma sigillata* Reeve (Conch. Icon., Vol. 1, *Pleurotoma*, pl. 40, species 363, 1846), which Tryon says comes from South Africa.

Variety **graciosana**, s. s.

Shell solid, with a comparatively wide concave area above the anal fasciole sculptured with two or three spiral lines; columella shorter, more twisted in the adult, anterior canal shorter, more conspicuously notched in the adult.

Pliocene: Type locality only.

Moniliopsis graciosana (Arnold) variety **mercedensis** (Martin)

Plate 26, Figure 30

Drillia mercedensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 194, pl. 22, figs. *2a*, *2b*, *2c*, 1914; Vol. 9, pp. 229, 230, 231, 233, 239, 243, 257, 1916; Nomland, Vol. 10, p. 221, 1917.

Turris (*Drillia*) *mercedensis* (Martin), Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, pl. 2, figs. *7a*, *7b*, 1916.

Clathrodrillia diegensis Oldroyd, Nautilus, Vol. 34, p. 115, pl. 5, fig. 12, 1921.

Clathrodrillia (*Moniliopsis*) *mercedensis* Martin, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 77, 78, 79, 1929.

Shell like that of the typical variety but thinner, with a narrower concave area above the anal fasciole and frequently only one spiral groove in this area; columella longer, slenderer, straighter, anterior canal longer, narrower.

Dimensions: Altitude, 28 mm.; length of aperture, 12 mm.; diameter of body whorl, 11 mm.

Type specimens: Both at the University of California.

Type localities: Of *mercedensis*, Merced series, Pliocene, near Santa Rosa, north of San Francisco Bay; of *diegensis*, upper Pleistocene of Pacific Beach, San Diego.

Pliocene: Merced and Purisima formations of middle California in a number of localities, and the Wildcat formation of northern California (Martin); Etchegoin of the Coalinga district (Nomland); upper Pliocene of Los Angeles (Moody); upper Pico of Ventura Co. (Waterfall).

Pleistocene: Lower San Pedro series, "Saugus," Las Posas formation of loc. 233, S. D. S. N. H., north of Arroyo Santa Rosa, Ventura Co., southern California, one specimen (U. S. G.); upper San Pedro of Pacific Beach, San Diego (Arnold, under *graciosana, s. s.;* T. S. Oldroyd); "Saugus" of Ventura Co. (Waterfall).

The characters relied upon by Martin to distinguish this variety from *graciosana* are probably of no real significance, though it may be possible to distinguish it by means of the characters described above as a variety of doubtful value. The width of the bands between the spiral grooves on the body whorl is very variable, being greatly dependent upon the state of preservation; and these bands are just as apt to be as wide in the typical variety as in *mercedensis.* The typical variety appears to be an unusual form or gerontic stage, occurring in beds of approximately the same age as those containing *mercedensis;* and the name *graciosana* may have been overlooked because of the poor original illustration, whereas the more normal *mercedensis* has been reported from numerous localities. A few of the fossil specimens of *mercedensis* have as narrow spiral bands on the body whorl as does *quentinensis* (Dall), and it is not improbable that the latter is the same form still living.

Moniliopsis quentinensis (Dall)

Cryptogemma quentinensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 32, pl. 9, fig. 9, 1919.

Shell much like that of *M. graciosana* variety *mercedensis* but younger, with the posterior notch more squarely on the periphery so that the axial riblets on the periphery curve around it crescent shaped, and with the spiral cords on the lower part of the body whorl much narrower.

Dimensions (from Dall): Height of shell, 12 mm.; of last whorl, 9 mm.; diameter, 9 mm.

Type specimen: No. 209,417 in the U. S. National Museum.

Type locality: Off Cape San Quintin, Lower California, in 359 fathoms.

Living: Known only from the type locality.

This form may or may not be distinct from *graciosana.* So little is known about it that its status cannot be determined, but it is worth while to point out that it is approached by variations of *graciosana* variety *mercedensis. M. quentinensis* is in the transition zone between *Moniliopsis* and *Hemipleurotoma* (the latter of which was formerly known under the name *Cryptogemma,* to which Dall assigned this species), and it is assigned to *Moniliopsis* only because it is so closely related to *graciosana.* There are forms of *Pleurotomoides* that can be distinguished only by the position of the notch.

Genus HEMIPLEUROTOMA Cossmann, 1889

Hemipleurotoma Cossmann, Ann. Soc. Roy. Malac. Belg., Vol. 24 (Ser. 4, Vol. 4), p. 260, 1889; Ess. Paléo. Comp., Vol. 2, p. 78, 1896.

Coronia de Gregorio, Ann. Geol. Paléo., Vol. 7-8, 1890, type *Pleurotoma acutirostra* Conrad, *fide* Cossmann.

Cryptogemma Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 318, 1918, type (by original designation) *Gemmula benthima* Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 267, pl. 1, fig. 7, pl. 13, fig. 4, 1908, living from the Galapagos Islands to Ecuador in very deep water.

Type (by original designation), *Pleurotoma archimedis* Bellardi, Mem. R. Accad. Sci. Torino, Ser. 2, Vol. 29, p. 30, pl. 1, fig. 18, 1878, middle Miocene of Italy. Bellardi's original figure is here reproduced, plate 26, figure 36.

Shell of medium or small size, thin, high-spired; whorls prominently angulated, the angulation coming at about the middle of the spire whorls, being surmounted by numerous small nodes as in *Gemmula*, and crossed by fine spiral threads, the rest of the sculpture consisting of distant spiral cords; aperture moderately elongate, posterior notch V-shaped, situated directly on the end of the angulation and being the cause of the beaded peripheral anal fasciole, inner lip resorbed, columella only slightly flexed, anterior canal moderately long, fairly narrow but not very clearly defined; operculum oval, with an apical nucleus.

Geologic range: Lower Eocene to Recent (Cossmann).

Distribution: Deep water of the Pacific, and probably also of the Atlantic.

Hemipleurotoma is distinguished from *Gemmula* by its smaller, thinner, nearly always decorticated shell, and by its simple outer lip and shorter anterior canal. It is intermediate in character between *Gemmula* and *Moniliopsis*, and is distinguished by its *Turris* notch from *Spirotropis* and *Pleurotomoides*.

Cossmann complicated the situation somewhat by citing *Pleurotoma denticula* Basterot as a neotype, but fortunately this species, unlike some of the others assigned by Cossmann to his genus, appears to be congeneric with the real type. *Pleurotoma denticula* Basterot is a Miocene species in Europe, but Heilprin reports it in the Eocene of Alabama.[1] *Turris cingulifera* (Lamarck), assigned by Cossmann to *Hemipleurotoma*, is probably a *Turris* in spite of its short anterior canal.

Of the species assigned by Dall to *Cryptogemma*, the type appears to be the only one that belongs in this genus. The others should be distributed among the genera *Spirotropis, Pleurotomoides, Taranis, Moniliopsis*, etc. No species belong to *Hemipleurotoma*, as here outlined, that do not have the posterior notch on the peripheral keel. *Moniliopsis quentinensis* (Dall) is intermediate between *Moniliopsis* and *Hemipleurotoma* and might appropriately be classed here; but, as explained in the discussion of that species, its specific relationships tie it more closely to *Moniliopsis*. Dall intended to describe a species collected off the Hawaiian Islands in 284-290 fathoms by Dr. Heath as "*Turris incilis*" and also as "*Pseudogemmula pailoloensis*," according to specimens in the Oldroyd Collection at Stanford University; but apparently he never did so. The two are identical and belong to *Hemipleurotoma*. This form shows clearly that *Hemipleurotoma* is closely related to *Turris*.

Genus TARANIS Jeffreys, 1870

Taranis Jeffreys, Ann. and Mag. Nat. Hist., Ser. 4, Vol. 5, p. 447, 1870.

Type (by monotypy), *Trophon mörchi* Malm, Göteborgs Kongliga Vetenskapsoch Vitterhets-Samhället (Gothenburg), Handlingar, Ny Tidsföljd, Vol. 8, p. 130, pl. 2, fig. 15, 1863, illustrated also by Sars, Moll. Reg. Arct. Norv., p. 220, pl. 17, fig. 8, 1878, also by Tryon, Man. Conch., Vol. 6, p. 315, pl. 29, fig. 66, 1884, and discussed by Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 301, 1915, though Harmer's figure is not typical; living on both sides of the Atlantic, from Norway to the Mediterranean and from Rhode Island to the Gulf of Mexico; Pleistocene of England and possibly also of Italy.

Shell small, spire elevated; whorls sculptured by a few prominent spiral ridges which are sometimes arranged so that the whorls have an angulated appearance, these ridges crossed by more or less prominent lines or thin lamellæ of growth which slope backward from the top of the whorls to the most prominent upper spiral, where they turn suddenly and begin sloping forward, giving the spire whorls a zigzag pattern and indicating a shallow, v-shaped posterior notch on the outer lip some distance below the suture; aperture less than half the length of the shell, ovate, columella thin, curving to the left, anterior canal not clearly defined, rather short, not notched; animal inoperculate.

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[1] Proc. Acad. Nat. Sci., Phila., p. 214, pl. 13, fig. 10, 1879 = *P. nodocarinata* Gabb?

Geologic range: Upper Pliocene to Recent.

Distribution: Reported from nearly everywhere in the northern hemisphere.

This interesting little genus is clearly related to *Hemipleurotoma;* and the more nearly smooth species *incultus* might be mistaken for a small *Spirotropis.* It is very unlikely that it has anything to do with *Mangelia,* with which it has usually been classed on account of being inoperculate. It is distinguished from *Teres,* perhaps artificially, by the position of the posterior notch.

Taranis strongi (Arnold)

Plate 26, Figure 37

Mangilia (*Taranis*) *strongi* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 215, pl. 9, fig. 7, 1903.
Taranis strongi Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 83, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 151, 1927.

Shell large for the genus, spire high; whorls sculptured by about seven spiral ridges, the largest on the angle marking the trace of the anal fasciole and the place where the growth lines turn, one smaller above, close to the suture, and five below diminishing in prominence, only the uppermost of which shows on the spire whorls, growth lines weak; aperture short, ovate, columella short, turning to the left, anterior canal short, not defined, slightly recurved.

Dimensions: Altitude, 12 mm.; length of aperture, 5 mm.; diameter of body whorl, 5.5 mm.

Type specimen: No. 162,549 in the U. S. National Museum.

Type locality: Lower San Pedro Pleistocene of Deadman Island, San Pedro Harbor, Los Angeles Co., Calif.

Pleistocene: "Pliocene" of Deadman Island and Santa Monica (Arnold); lower San Pedro series of San Pedro and Deadman Island (Arnold); upper San Pedro series (Palos Verdes) of Crawfish George's (Arnold).
Living: Forrester Island, Alaska, to San Diego, California (Dall).

This species is distinguished from *mörchi* by its larger size, its relatively shorter aperture and columella, and its less prominent growth lines. It has, however, all the generic characters of *mörchi*, and there is no question about its belonging to the genus *Taranis.* *T. incultus* is a closely related species or variety with weaker spiral sculpture.

Taranis incultus (Moody)

Borsonia inculta Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 54, pl. 1, figs. 2*a*, 2*b*, 1916.

Shell like that of *T. strongi,* but with faint spiral sculpture.

Dimensions: Altitude, 13.5 mm.; length of aperture, 6 mm.; diameter of body whorl, 6.9 mm.

Type specimen: No. 11,081 at the University of California.

Type locality: Fourth and Broadway, Los Angeles.

Upper Pliocene: Type locality.

This form may be a variety or even just a variation of *strongi.* It closely resembles a small typical *Spirotropis.*

Genus TERES Bucquoy, Dautzenberg, and Dollfus, 1883

Teres Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 86, 1883; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 130, 1896.
Teretia Norman, 1888, *Teres* emended; Monterosato, Nat. Sicil., An 9, p. 187, 1890; Dautzenberg and Fischer, Rés. Camp. Sci. Albert I, Prince de Monaco, Vol. 37, p. 50, 1912; Iredale, Proc. Zool. Soc. London, Vol. 13, p. 32, 1918.

Tomopleura Casey, Trans. Acad. Sci. St. Louis, Vol. 14, p. 138, 1904, type (by original designation) *Pleurotoma nivea* Philippi, Zeitschr. f. Malak., p. 92, 1851, operculum figured by Hedley, Rec. Australian Mus., Vol. 13, p. 218, pl. 42, fig. 4, 1922, living Formosa, and Karachi, India; Melvill, Proc. Malac. Soc. London, Vol. 12, p. 146, 1917. Melvill states that *Pleurotoma violacea* Hinds, Zool. Voy. *Sulphur*, Moll., p. 16, pl. 5, fig. 8, 1844, Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 22, species 186, 1845, Tryon, Man. Conch., Vol. 6, p. 169, pl. 4, fig. 12, pl. 3, figs. 29, 29*a*, 1884, not *Pleurotoma violacea* Mighels and C. B. Adams, 1842, is merely a color variety of *nivea*.

Turridrupa Hedley, Rec. Australian Mus., Vol. 13, p. 226, 1922, type (by original designation) *Pleurotoma acutigemmata* Smith, Ann. and Mag. Nat. Hist., Ser. 4, Vol. 19, p. 489, 1877, synonymy by Hedley. *loc. cit.*, and illustration, pl. 42, figs. 12, 13, 1922.

Type (by original designation), *Pleurotoma anceps* Eichwald, Naturhist. von Lith. und Volh., p. 225, 1830, described and illustrated by B., D., and D., *op. cit.*, p. 87, text figure 1, 1883, by Sars, Moll. Reg. Arct. Norv., p. 219, pl. 17, fig. 9, 1878, and by Tryon, Man. Conch., Vol. 6, p. 313, pl. 32, fig. 31, 1884 + *Pleurotoma teres* Forbes, 1844 (not "*teres* Forbes" in Reeve, January, 1844), living Norway to the Mediterranean.

Shell small, spire moderately high; whorls sculptured with revolving cords which sometimes show through on the interior and crenulate the outer lip, axial striations and growth lines much less prominent; aperture about two-fifths the length of the shell, outer lip curving back to a deep, rounded notch close to the suture, the notch leaving behind it a broad, smooth fasciole, columella light, slightly flexuous, anterior canal indistinctly defined, short, not notched; animal (frequently ?) operculate.

Geologic range: Miocene to Recent (B., D., and D.).

Distribution: Practically world wide.

This little genus is like *Taranis* except that the posterior notch is deep and close to the suture. It is clearly shown in the illustration of the type by Bucquoy, Dautzenberg, and Dollfus. The two little species described by Dall in 1919 as *Taranis panope* and *Taranis zeuxippe* from the equatorial region of the eastern Pacific probably belong here, and probably also most of Hedley's *Filodrillia*.

Teres also bears some resemblance to *Raphitoma*, especially in Sars' figure of *anceps* and in *niveus;* but *Raphitoma* is larger, with stronger axial sculpture, and is said to be always inoperculate.

Subgenus **ASTHENOTOMA** Harris and Burrows, 1891

Oligotoma Bellardi, Bull. Società Malac. Ital. (Pisa), Vol. 1, p. 21, 1875; R. Accad. Sci., Torino, Memorie, Ser. 2, Vol. 29, p. 235, 1878; not *Oligotoma* Westwood, 1836; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 329, 322, 1918.

Asthenotoma Harris and Burrows, Eocene and Oligocene Beds of the Paris Basin, p. 113, 1891, new name for *Oligotoma* Bellardi; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 104, 1896; Hedley, Rec. Australian Mus., Vol. 13, p. 218, 1922; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 197, 1928.

Type (by monotypy), *Pleurotoma meneghinii* Mayer = *Pleurotoma tuberculata* Pusch, *fide* Bellardi, 1878, p. 239, pl. 7, fig. 26, Miocene of Italy; originally described and figured by Pusch, in Polens Paläontologie, p. 143, pl. 12, fig. 2, (Stuttgart) 1837.

The type of this genus or subgenus has generally been cited as *Pleurotoma basteroti* Desmoulins, 1842, Miocene of Europe, which may be the same as *tuberculatus* according to Dall, though Woodring does not think so. *P. basteroti* is a form like *Teres* with an obscure plication on the pillar. Many of the species assigned to *Asthenotoma* and *Oligotoma* by Harmer and others might be better placed in *Moniliopsis*. It will be remembered that *Moniliopsis* belongs to the group of genera which has a tendency to develop columellar plications, though typically it does not have one. *Endiatoma* Cossmann, 1896, is similar.

Genus CLAVUS Montfort, 1810

Clavus Montfort, Conchyl. Syst., Vol. 2, p. 434, 1810; Tryon, Man. Conch., Vol. 6, pp. 155, 185, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 315, 324, 1918; Hedley, Rec. Australian Mus., Vol. 13, p. 254, 1922; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 160, 1928.

Clavicantha Swainson, Treat. Malac., pp. 155, 314, 1840, original list includes, *imperialis, spirata, conica, echinata* and *auriculifera*, all of Lamarck and all referred to figures in the Encyclopedia Méthodique; Herrmannsen, Ind. Gen. Malac., Vol. 1, p. 246, 1846, type designated, *Pleurotoma echinata* Lamarck.

Tylotia Melvill, Proc. Malac. Soc. London, Vol. 12, p. 160, 1917, type (by original designation) *Strombus canalicularis* Bolten + *Pleurotoma auriculifera* Lamarck, Hist. Nat. Anim. s. Vert., Vol. 7, p. 91, 1822, illustrated by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 8, species 69, 1843, also, as *Drillia auriculifera* Lamarck, by Tryon, Man. Conch., Vol. 6, p. 185, pl. 8, fig. 25, 1884, +"*Strombus lividus* Linnæus," Chemnitz, Neues Syst. Conch. Cab., Vol. 9, p. 193, pl. 136, figs. 1269, 1270, 1786, also noted by Gmelin in Linnæus, Syst. Nat., Ed. 13, p. 3525, 1791, and as "*Drillia livida* Linnæus" by Hedley, Proc. Linn. Soc. New South Wales, Vol. 34, p. 453, 1909, Recent, Philippine Islands.

Type (by original designation), *Clavus flammulatus* Montfort, described *loc. cit.*, and figured pl. 109; + *Clavatula echinata* Lamarck, Ency. Méth. (Vers), Liste, p. 8, pl. 439, fig. 8, 1816; *Pleurotoma echinata* Lamarck, Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 45, pl. 20, figs. 2, 1839-40; Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 6, species 48, 1843; Tryon, Man. Conch., Vol. 6, p. 185, pl. 9, fig. 31, 1884; = *Strombus lividus* Linnæus, Syst. Nat. Ed. 10, p. 746, 1758, *fide* Hedley, Rec. Australian Mus., Vol. 13, p. 255, 1922, *cf.* also Iredale, Proc. Malac. Soc. London, Vol. 12, p. 92, 1916; Recent, west coast of Africa. One of Kiener's figures is reproduced herewith, plate 26, figure 1.

Shell of medium size, spire usually high, turreted; whorls sculptured on the angle with nodes or with more or less oblique ribs extending downward from the angle (in cases where there is no pronounced angle extending downward from a point below the anal fasciole, which is free from them), spiral sculpture of variable strength, sometimes nearly obsolete, usually much finer on the anal fasciole, consisting of spiral lines or cords or grooves, growth lines usually evident; aperture a third or two-fifths the length of the shell, rarely approaching a half, the main part ovate, but each end prolonged into a deep notched canal, outer lip thickened or thin according to whether the shell is at the rib-forming growth stage or not, when thin sometimes crenulated by the spiral sculpture, but never denticulate within, outer lip often receding anteriorly at the base of the convex portion of the body whorl or even with a notch as in *Strombus*, posteriorly with a deep, rounded notch close to the suture but separated from the suture by a mound or ridge of light-colored material or callus which often extends in an arc around the upper end of the aperture and joins with the inner lip, which is usually heavily encrusted with smooth callus, columella usually short, straight, but in a few cases a little more elongate and slightly bent to the left, anterior canal usually indistinctly defined by the incurving of the body whorl near the Stromboid notch but often so short that this feature is not noticeable, rather wide and deep, flaring a little at the very end, usually deeply notched behind, the notch causing a siphonal fasciole that the inner lip has difficulty in covering up; operculum thin, horny, usually with a terminal nucleus.

Geologic range: Eocene to Recent (Cossmann, etc.).

Distribution: Tropical and warm temperate waters of all oceans.

The name *Clavus* is antedated in the *Turridæ* only by *Turris* Bolten and *Clavatula* Lamarck, both of which apply to different genera; and as Cossmann and others were wrong in supposing that the name was invalidated by *Clava*, and as it is inadmissible to use it as a subgenus of the later name *Drillia*, it is here applied to the most conspicuous genus of that branch of the *Turridæ* that is characterized by a subsutural callus at the top of the inner lip, a deep posterior notch, a notched anterior canal, and a tall spire. This genus has recently been multiplied into many genera; but the present writers feel that after a few more distantly related groups are removed (*Moniliopsis, Pseudomelatoma*, etc.), the remaining forms make such a well-defined unit that nothing is to be gained by further complicating the generic nomenclature. A few subgenera are here recognized for convenience in classifying.

Clavus is undoubtedly closely related to *Clavatula*, as used here *sensu lato* to include not only the specialized typical Clavatulas that are grading over into *Perrona* but also the generalized, primitive type of the subgenus *Knefastia*. *Clavus* is distinguished from *Clavatula* by its short, notched anterior canal, by the callus mound at the top of the inner lip, by the deeper posterior notch, the outer lip standing out a considerable distance practically unsupported, by the lack of the sculptured band above the anal fasciole, and usually by its simpler sculpture. When *Clavus* has spines as in *C. canalicularis* (Bolten), the spines are below the fasciole, whereas the spines that occur sometimes in *Clavatula* are above the fasciole. *Clavus* (*Clathrodrillia*) *flavidulus* (Lamarck) is closest to *Knefastia*, having sculpture in both directions and a somewhat longer canal; but it has the *Clavus* posterior notch and callus patch. Occasionally immature specimens and even a few adults may lack the *Clavus* patch, but they can usually be told by their other characters or by their specific relatives.

Clavus is similarly distinguished from *Turricula*. The writers disagree with Dall, who, in 1918, referred *Turricula maculosa* (Sowerby) to *Clavus;* for that species has a longer anterior canal, not notched behind, and a shallower, unarmored posterior sinus. *Clavus unimaculatus* (Sowerby) is a typical *Clavus* approximating *maculosa* in appearance but showing all the distinguishing generic characters. *Pseudomelatoma* might sometimes be confused with *Clavus* in fossils that lack the last part of the body whorl; but even the fossils can usually be distinguished by the band of nodes above the fasciole. When the lip is intact, *Pseudomelatoma* is distinguished by the same characters as *Clavatula*.

On the other hand, *Clavus* unquestionably grades into the smaller inoperculate Turrids, such as *Mangelia* and *Clathurella*. *Clathurella* is the closest, having the same general shape as *Clavus*, with the same kind of aperture except that *Clavus* never has denticles on the outer lip; and it would be surprising if the young of some of the many-whorled clathrate species, such as *flavidulus* were not described as new species of *Clathurella*. The subgenus *Bela* of *Mangelia* resembles the young of *Clavus* (*Cymatosyrinx*), but never has a subsutural callus. *Bellaspira* seems to be intermediate between *Bela* and *Clavus* (*Drillia*), having a small shell and a nearly obsolete sinus as in *Bela*, but a thick shell, a small callus patch at the top of the outer lip, and an operculum as in *Drillia*.

Subgenus **CLAVUS**, s. s.

Shell with nearly obsolete sculpture except for a row of sharp, rounded nodes or hollow spines on the angle.

This subgenus includes *lividus* (Linnæus) from west Africa, *canalicularis* (Bolten) from the Philippines, and *unimaculatus* (Sowerby), ranging from Panama to the Gulf of California. A Gulf of California specimen of the last-named species is figured herewith, plate 26, figures 2*a*, 2*b*.

Subgenus **CYMATOSYRINX** Dall, 1889

Cymatosyrinx Dall, Bull. Mus. Comp. Zool., Vol. 18, p. 95, 1889; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 86, 1896; Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, p. 203, 1925.

Elæocyma Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 317, 1918, type (by original designation) *Drillia empyrosia* Dall (see *C. pallidus* below).

Type (by original designation), *Pleurotoma lunatum* Lea, Trans. Amer. Phil. Soc., New Series, Vol. 9, p. 269, pl. 37, fig. 93, 1846, illustration reproduced herewith, plate

26, figure 7; Tertiary of Petersburg, Virginia, said by Dall to be Miocene, range given as Miocene to Pliocene (Dall).

Shell like that of the typical subgenus but with the nodes on the angle extended downwards as long, curving costæ, fine spiral grooves sometimes evident in the interspaces.

Geologic range: Miocene to Recent.

Distribution: California and Florida to Panama, probably elsewhere.

This subgenus is so close to the typical subgenus that it might better be considered a section or a synonym, as Cossmann considered it. There is no reason whatever for separating *Elæocyma.* Some of the smaller species like *C. hemphilli* (Stearns) might be sectionally separable, but for the present the writers think it better not to make any more subdivisions.

Clavus (Cymatosyrinx) pallidus (Sowerby)

Plate 26, Figures 16*a*, 16*b*, 17

Pleurotoma pallida Sowerby, Proc. Zool. Soc. London, p. 137, 1833; Müll., Synop. Nov. Test. Viv., p. 113, 1836; Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 16, fig. 134, 1843; Adams, Cat. Sh. Panama, p. 146, 1852.

Drillia pallida Sowerby, Tryon, Man. Conch., Vol. 6, p. 196, pl. 14, fig. 8, 1884.

Drillia empyrosia Dall, Nautilus, Vol. 12, p. 127, 1889; Proc. U. S. Nat. Mus., Vol. 24, p. 516, pl. 39, fig. 5, 1902.

Drillia johnsoni Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 206, pl. 8, fig. 17, 1903; Smithsonian Misc. Coll., Vol. 50, Pt. 4, pl. 54, fig. 13, 1907; Arnold and Anderson, Bull. 322 U. S. Geol. Survey, pl. 21, fig. 13, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914.

Drillia waldorfensis Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 13, pl. 54, fig. 12, 1907; Arnold and Anderson, Bull. 322 U. S. Geol. Survey, pl. 21, fig. 12, 1907.

Elæocyma empyrosia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 12, pl. 4, fig. 1, 1919.

Elæocyma ægina Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 12, pl. 4, fig. 2, 1919.

Elæocyma halocydne Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 11, pl. 4, fig. 4, 1919.

Elæocyma ianthe Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 9, pl. 4, fig. 6, 1919.

Cymatosyrinx hecuba Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 9, pl. 20, fig. 9, 1919.

Clathrodrillia paziana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 14, pl. 5, fig. 1, 1919.

Cymatosyrinx (*Elæocyma*) *johnsoni* Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 69, 1921.

Cymatosyrinx (*Elæocyma*) *empyrosia* Dall, Bull. 112 U. S. Nat. Mus., p. 69, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 68, Pt. 3, pl. 100, fig. 5, 1927.

Cymatosyrinx (*Elæocyma*) *halocydne* Dall, Bull. 112 U. S. Nat. Mus., p. 69, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, pl. 19, fig. 5, 1927.

Shell of large or medium size, spire high; whorls of moderate convexity below the concave anal fasciole, sculptured with 10 to 15 rather low, sharp (except where worn rounded), distant, axial ribs which are barely distinguishable from the strongly curving growth lines on the anal fasciole, but appear quite strong on the side of the whorl, where they descend more or less obliquely, growing faint on the base of the body whorl, and curving around again past the vertical, ribs on the early whorls fewer and less noticeably oblique, but on the body whorl and sometimes on the penultimate whorl becoming irregular and much more oblique, either changing into fewer coarse waves, or, if the waves die out, breaking up into many irregular riblets hardly distinguishable from the growth lines, spiral sculpture of sharp grooves with flat-topped interspaces, usually worn off the ribs; aperture varying from a third to two-fifths the length of the shell, the columella and anterior canal sometimes somewhat elongated, especially in young specimens, but otherwise typical of *Cymatosyrinx,* the strong labial calluses not developing fully until the shell reaches the adult stage.

Dimensions of large specimen with short aperture: Altitude, 41 mm.; length of aperture, 13 mm.; diameter of body whorl, 13 mm.; of Pliocene specimen, here figured: altitude, 22 mm. (allowing 1 mm. for broken apex); length of aperture, 8 mm.; diameter of body whorl, 8 mm.

Type specimens: Of *pallidus,* in the British Museum (?); of *empyrosia,* in the Oldroyd Collection at Stanford University; of all the others, in the U. S. National Museum, *johnsoni* No. 162,537, *waldorfensis* No. 165,270, *ægina* No. 266,371, *halocydne* No. 216,748, *ianthe* No. 212,367, *hecuba* No. 73,995, and *pazianus* No. 311,372.

Type localities: Of *pallidus*, Panama; of *empyrosia* and *halocydne*, in deep water off San Pedro, Calif.; of *johnsoni*, upper San Pedro Pleistocene of San Pedro; of *waldorfensis*, Pliocene of the Waldorf asphalt mine, Santa Barbara Co.; of *ægina*, *ianthe*, and *hecuba*, Gulf of California; of *pazianus*, La Paz, Lower California.

M. Pliocene: Type locality of *waldorfensis;* Holser Canyon, Los Angeles Co., north of the Santa Clara Valley (English); S. D. S. N. H. loc. 217*b*, Holser Canyon, six specimens (H. R. G.).
Pleistocene: Type locality of *johnsoni;* Timber Canyon, Ventura Co. (collection at Stanford University).
Living: Santa Barbara to Panama.

The reader will probably be surprised by the synonymy given above, and it may be of help to note the different degrees of assurance with which the names are synonymized. *C. pallidus* is unknown to the writers except in Reeve's figure and the original description, which indicate a shell exactly like *empyrosia* except that it is said to be light colored and the basal extremity of the columella is somewhat twisted to the left. As one specimen of *empyrosia* in the Oldroyd Collection at Stanford University is light colored, the color difference is probably not of significance; but it is barely possible that the twist of the columella might be an indication that the forms are different species. The synonymy of *johnsoni* with *empyrosia* is certain. The form *waldorfensis*, although it appears to have a narrower shell, was described from a locality at which *johnsoni* occurs, and actual measurements show that its shell is not appreciably narrower than that of small specimens of *johnsoni*. Living specimens show that the form of the costæ on *empyrosia* varies, that *ægina* is merely an individual variation with the costæ stronger and somewhat node-like at the top, and that *hecuba* is but a worn specimen. The form *halocydne* is an extreme with more numerous costæ, the costæ being extremely oblique, low, and irregular on the last two whorls, and the anterior canal is slightly longer. This form might be separable as a variety; but the condition of the ribs on the last whorl appears to be merely a gerontic character, and the length of the canal an individual or growth-stage variation. The form *ianthe*, which is a *pazianus* with a mature aperture, might also be distinguished as a variety with longer anterior canal, more convex whorls, stronger spiral grooves, and smaller size. The specimens from Holser Canyon are like this last form, though somewhat larger. In some cases weathering has hollowed out the anal fasciole on these specimens leaving a *Pseudomelatoma*-like band above.

C. ærope (Dall),[1] from the Gulf of California, looks very much like a young *empyrosia* or *pallidus* (though its aperture shows it to be mature), and it may really be just another variety or synonym. *C. alcyone* (Dall)[2], also from the Gulf of California, which was named the type of the section *Kylix*,[3] may be a related species with the apertural callus not yet developed, resembling somewhat the form *pazianus*.

Clavus (Cymatosyrinx) hemphilli (Stearns)

Plate 26, Figure 8

Pleurotoma (Drillia) hemphilli Stearns, Conchological Memoranda, No. 7, p. 2, separately printed, Journal & Argus Print, Petaluma, Calif., August 28, 1871; Proc. Calif. Acad. Sci., Vol. 5, p. 80, pl. 1, fig. 3, 1873.
Drillia hemphilli Stearns, Tryon, Man. Conch., Vol. 6, p. 185, pl. 13, fig. 49, 1884; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 204, pl. 5, fig. 8, 1903.
Clathurella plicatella Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 289, 1908.
Cymatosyrinx plicatella Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 7, pl. 20, fig. 4, 1919.

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[1] *Elæocyma aerope* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 13, pl. 1, fig. 3, 1919.

[2] *Clathrodrillia? (Kylix) alcyone* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 20, pl. 2, fig. 3, 1919.
Mangilia? hermione Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 70, pl. 19, fig. 6, 1919 (young).
?Clathrodrillia? (Kylix) alcmene Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 19, 1919.

[3] *Kylix* Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 327, 1918, *nomen nudum* until 1919.

Cymatosyrinx ? ferminiana Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 7, pl. 8, fig. 4, 1919.
Cymatosyrinx ? palmeri Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 8, pl. 19, fig. 7, 1919.
Elæocyma attalia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 10, pl. 18, fig. 7, 1919.
Elæocyma arbela Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 10, pl. 4, fig. 3, 1919; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.
Elæocyma æolia Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 11, pl. 3, fig. 1, 1919.
Cymatosyrinx (*Elæocyma*) *hemphilli* Stearns, Dall, Bull. 112 U. S. Nat. Mus., p. 69, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 69, 1927.
Elæocyma hemphilli Stearns, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Shell small, rather high spired; whorls moderately rounded, sculptured with 10-14 usually distinct, distant, somewhat oblique axial riblets, the riblets often becoming obsolete or indistinct on the body whorl, and occasionally on one or more of the spire whorls, riblets broken posteriorly by the anal fasciole, which separates off a *Pseudomelatoma*-like nodulous band just below the suture, the band being much more conspicuous at some times than at others, spiral sculpture of a few fine, sharp, distant grooves showing only in the interspaces between the riblets and on the columella, or not at all, sometimes fairly conspicuous on specimens with obsolete riblets; aperture about a third the length of the shell, ovate, notched at both ends, the posterior notch being deep and narrower and close to the suture, the anterior comparatively broad and shallow, the top of the inner lip with a mound of callus bordering the notch, columella short, anterior canal sometimes defined, short.

Dimensions: Altitude, 12 mm.; length of aperture, 4 mm.; diameter of body whorl, 4 mm.

Type specimens: All (except perhaps that of *hemphilli*) in the U. S. National Museum, *plicatellus* No. 110,604, *ferminianus* No. 214,267, *palmeri* No. 56,036, *attalia* No. 168,677, *arbela* No. 106,495, *æolia* No. 208,592.

Type localities: Of *hemphilli*, Todos Santos Bay, Lower California; of *plicatellus*, Panama Bay; of *ferminianus*, Point San Fermin, Lower California; of *palmeri*, head of the Gulf of California; of *attalia*, west coast of Mexico, probably near Mazatlan; of *arbela*, Scammons Lagoon, Lower California; of *æolia*, Cape Tepoca, Gulf of California.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, Los Angeles Co. (Arnold); Barlow Canyon, Ventura Co. (Arnold); 26th St. and Spanish Bight, San Diego (Arnold); San Quintin Bay, Lower California (Jordan); loc. 249 S. D. S. N. H. north of Ventura, two specimens (U. S. G.); upper San Pedro series of Los Cerritos (= Signal Hill), San Pedro, and Crawfish George's (Arnold); upper San Pedro of the palisades north of Santa Monica (F. C. Clark).

Living: Santa Barbara, California, to Panama.

This species, like *pallidus*, is variable in form and has received many names. The most striking variation is that named *attalia*, which has a tall, narrow spire and feeble ribs. Specimens of this variation are labeled *hemphilli* in the Oldroyd Collection at Stanford University. The type figure of *hemphilli* shows a shell with only moderately high spire, the ribs becoming obsolete on the last whorl. Other variations have strong, sharp ribs even on the body whorl, more or less prominent spiral sculpture and a sutural band, etc., or different combinations of these characters. The sutural band recalls *Pseudomelatoma*, but the subsutural callus on the inner lip shows that the species belongs to *Clavus*.

C. hemphilli is smaller, with finer sculpture than *pallidus*. It is difficultly distinguished from *C. elissa*, which has a shorter, more ovate shape, low broad riblets, and practically no spiral sculpture, *C. elissa* being perhaps but a variety of *hemphilli*. *C. albicostatus* (Sowerby),[1] from the Galapagos Islands, is very similar and may be the earliest name for this species. It is somewhat larger and appears to lack the posterior band.

Clavus (Cymatosyrinx) elissa (Dall)

Cymatosyrinx elissa Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 6, pl. 20, fig. 1, 1919.
Cymatosyrinx hespera Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 6, pl. 20, fig. 2, 1919.
Cymatosyrinx ? lalage Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 7, pl. 20, fig. 3, 1919.
? Cymatosyrinx idothea Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 8, pl. 21, fig. 11, 1919.

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[1] *Pleurotoma albicostata* Sowerby, Proc. Zool. Soc. London, p. 135, 1833; Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 8, fig. 62, 1843. *Drillia albicostata* Sowerby, Tryon, Man. Conch., Vol. 6, p. 205, pl. 13, fig. 57, 1884.

Shell much like that of *hemphilli*, but with a shorter spire, giving it a more ovate outline, with low, faint axial ribs and practically no spiral sculpture.

Dimensions: Altitude, 9 mm.; length of aperture, 3 mm.; diameter of body whorl, 3.5 mm.

Type specimens: In the U. S. National Museum, *elissa* No. 122,799*a*, *hespera* No. 122,799, *lalage* No. 55,491, *idothea* No. 96,194.

Type localities: Of *elissa* and *hespera*, Panama Bay; of *lalage*, Gulf of California; of *idothea*, Straits of Magellan, South America.

Living: Gulf of California to the Straits of Magellan.

Objectively considered, there is little to separate the named forms listed in the synonymy. The Patagonian form might be distinguishable by its more oblique ribs, but if the variability of this character is as great in this species as in *pallidus* and *hemphilli*, it will not serve to separate it.

Subgenus **CLATHRODRILLIA** Dall, 1918

Clathrodrillia Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 317, 1918.

Type (by original designation), "*Pleurotoma gibbosa* Reeve," Conch. Icon., Vol. 1, *Pleurotoma*, pl. 5, species 30, 1843; = *Murex gibbosus* von Born, Index Rerum Naturalium Musei Cæsarei Vindobonensis, p. 325, 1778; Testacea Mus. Cæs Vind., p. 321, pl. 11, figs. 12, 13, 1780, these figures reproduced here, plate 26, figures 3*a*, 3*b*; also illustrated by Chemnitz, Neues Syst. Conch. Cab., Vol. 11, p. 112, pl. 190, figs. 1833, 1834, not figs. 1829, 1830 (= *flavidulus* Lamarck var.), 1795; Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 35, pl. 16, fig. 2, 1839-40; Tryon, Man. Conch., Vol. 6, p. 179, pl. 9, fig. 54, 1884. Chemnitz says it comes from the Red Sea, a variety of the form which Lamarck later called *flavidulus*, Red Sea to Japan; but Tryon says it is from the West Indies, which is probably correct. Reeve and von Born did not give the locality.

Shell like that of the typical subgenus but sculptured with axial ribs instead of nodes and with prominent spiral cords overriding the ribs.

Geologic range: Pliocene to Recent (California).

Distribution: Warm and tropical oceans.

The close relation between this subgenus and the typical is illustrated by Reeve's remark that *C. unimaculatus* (Sowerby), a member of the typical subgenus, "may probably be merely a white variety of *Pl. gibbosa*." The intergradation with *Cymatosyrinx* is even more intimate, the separation being made merely on the strength of the spiral sculpture. Indeed, the distinctions between these three subgenera are so artificial that it would not be unreasonable to reduce them to the rank of sections or to abandon them entirely. The subgenus *Drillia* is shorter and smaller, with a few large, rounded axial ribs. The subgenus *Crassispira* has a sculptured band above the anal fasciole showing the relationship with *Clavatula*, and the sculpture usually has a more granular texture. Some species of *Clathrodrillia*, like *flavidulus* (Lamarck) (see plate 26, figures 4*a*, 4*b*), have a longer anterior canal and simulate *Clavatula* or *Turricula*, but the armored posterior notch shows that they belong to this group. Dall's *C.* (*Clathrodrillia*) *panthea*[1] is an illustration of this form. It is evident that the genera *Clavatula*, *Turricula*, and *Clavus* and the corresponding branches of the *Turridæ* intergrade at this point.

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[1] *Turricula* (*Surcula*) *panthea* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 4, pl. 1, fig. 5, 1919.

Clavus (Clathrodrillia) coalingensis (Arnold)

Plate 26, Figures 14*a*, 14*b*, 15

Pleurotoma coalingensis Arnold, Bull. 396 U. S. Geol. Survey, p. 90, pl. 22, fig. 2, Jan. 15, 1910, figure reprinted in Bull. 398, pl. 44, fig. 2, 1910.

Turris elsmerensis English, Univ. Calif. Publ. Geol., Vol. 8, p. 216, pl. 23, figs. 4*a*, 4*b*, 1914.

Turris (*Bathytoma*) *coalingensis* Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 203, 1916.

Turris coalingensis (Arnold), Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 213, 221, 1917.

Shell of medium size, spire moderately high; whorls with a rounded shoulder, sculptured with about ten rounded axial ribs extending from the shoulder downward and dying out on the lower part of the body whorl, spiral sculpture of three or four spiral grooves on the anal fasciole above the shoulder, on the rest of the whorl of spiral cords, two to four showing on the spire whorls, about fifteen on the body whorl, with a number of minor intercalaries, especially on the upper part of the whorls, sometimes very inconspicuous, sometimes almost as strong as the primary cords and making the spiral sculpture appear finer; aperture about two-fifths the length of the shell, lenticular, posterior notch deep and rounded, close to the suture, columella nearly smooth, with the posterior callus patch, if present, very inconspicuous, anterior canal poorly defined, moderately notched.

Dimensions: Altitude, 27 mm.; length of aperture, 12 mm.; diameter of body whorl, 11 mm.

Type specimens: Of *coalingensis*, No. 165,509 in the U. S. National Museum; of *elsmerensis*, in the collection of the University of California.

Type localities: Of *coalingensis*, basal portion of the Etchegoin formation, middle Pliocene, of the Coalinga district, middle California; of *elsmerensis*, lower Pliocene of Elsmere Canyon, Los Angeles County.

Lower Pliocene: Elsmere Canyon (English); Coalinga district (Nomland); localities 204 and 207, S. D. S. N. H., Elsmere Canyon, one specimen each (H. R. G.).

Middle Pliocene: Coalinga district (Arnold; Nomland).

It takes but a few specimens to illustrate the variation of this species and show that *elsmerensis* is the same as *coalingensis*. The nearest living form is *C. panthea* (Dall) from Panama, mentioned above, which is somewhat larger but may in time be found to be conspecific. The whole range of this species is much more significant than the isolated occurrences of several supposedly different forms. Although the callus patch at the top of the inner lip is not clearly shown on any fossil specimen seen by the writers, there can be little question about its specific relationships and its assignment to this group.

Clathrodrillia callianira Dall, 1919, from Lower California, also belongs to this group, but it has a relatively higher, narrower spire.

Subgenus **CRASSISPIRA** Swainson, 1840

Crassispira Swainson, Treat. Malac., pp. 152, 313, 1840, species included, *Pleurotoma bottæ* Auct. and *C. fasciata* Swainson, fig. 17*d*, p. 151; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 318, March, 1847, type cited *Pleurotoma bottæ* Valenciennes; Cossmann, Ess. Paléo Comp., Vol. 2, p. 85, 1896; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 317, 324, 1918; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 147, 1928.

Type (by subsequent designation, Herrmannsen, 1847), *Pleurotoma bottæ* Valenciennes in Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 33, pl. 15, figs. 2, 1839-40, these figures reproduced herewith, plate 26, figures 6*a*, 6*b*; living, Mazatlan, west coast of Mexico.

Shell like that of the typical subgenus but with a relatively longer aperture, with a smooth or sculptured band above the posterior notch and long axial costæ extending from the anal fasciole downward.

Geologic range: Eocene ?; Miocene to Recent; in California, Pliocene to Recent.

Distribution: Warm and tropical oceans.

The writers do not believe that there is any need for doubt concerning the type designation of this subgenus. The name *Pleurotoma bottæ* had evidently been circulating among conchologists a number of years before Kiener published it and credited it to Valenciennes; and as Kiener's work appeared at approximately the same time that Swainson's did, it is not unlikely that Swainson had not yet seen the pub'ished name. In any case Swainson apparently meant *Pleurotoma bottæ* as then generally understood by conchologists; and since Valenciennes in Kiener has full title to being an author, there is nothing to imply that *Pleurotoma bottæ* Valenciennes in Kiener was excluded from *Pleurotoma bottæ* Auctorum. Surely the name had not been published long enough to have been frequently misidentified and to cause Swainson to try to indicate the misidentification in the crude manner too frequently employed by later workers. Even in case *bottæ* were not accepted, Swainson's other species is almost surely a Turrid of this same group, the fact that Swainson considered it intermediate between the *Pyrenidæ* and the *Turridæ* not being significant.

There is some difficulty about the identification of *Pleurotoma bottæ*, which Reeve and Tryon considered the same as *incrassatus* (Sowerby), though the latter appears quite different. However, continued collecting along the coast of Mazatlan ought to yield some specimens and determine the specific identity of the name, and in the meantime it is clear enough to what group the species belongs. Woodring has figured a number of species illustrating the group, though none of them is as large as the type, which is two inches long.

Crassispira is difficult to distinguish from *Clathrodrillia*, for both have the *Clavus* generic characters and sculpture in both directions; but *Crassispira* does not have shouldered whorls and the suture is higher on the preceding whorl, somewhat as in *Clavatula*, with one or more spiral ridges and sometimes a band of nodular sculpture above the anal fasciole. The anterior canal is short and undefined. *Crassopleura* Monterosato may be a synonym.[1]

Clavus (Crassispira) montereyensis (Stearns)

Plate 26, Figure 9

Pleurotoma (*Drillia*) *montereyensis* Stearns, Conchological Memoranda, No. 7, p. 2, separately printed, Journal and Argus Press, Petaluma, Calif., August 28, 1871; Proc. Calif. Acad. Sci., Vol. 5, p. 80, pl. 1, fig. 2, 1873.

Drillia montereyensis Stearns, Tryon, Man. Conch., Vol. 6, p. 184, pl. 12, fig. 30, 1884; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 207, 1903.

Crassispira arsinoë Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 26, pl. 6, fig. 4, 1919.

Crassispira montereyensis Stearns, Dall, Bull. 112 U. S. Nat. Mus., p. 70, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 77, 1927.

Shell small, thick, spire moderately high; whorls not much inflated, sculptured with about thirteen low, indistinct axial riblets, riblets nodose below the anal fasciole and dying out downward, absent on the fasciole, and sometimes appearing as nodes on the band above the fasciole, spiral sculpture of indistinct cords making the riblets below the fasciole granular, anal fasciole smooth except for curving growth lines; aperture about a third the length of the shell, posterior notch some distance below the suture, deep, rounded, the space above it within the aperture filled with callus, inner lip encrusted, columella straight, not defined from the regularly curving outline of the body whorl, anterior canal not defined, short, broad, notched behind.

Dimensions: Altitude, 16 mm.; length of aperture, 6 mm.; diameter of body whorl, 6 mm.

Type specimens: Of *montereyensis*, in the U. S. National Museum (*fide* Oldroyd); of *arsinoë*, No. 56,135 in the U. S. National Museum.

Type localities: Of *montereyensis*, Monterey, Calif., of *arsinoë*, Bartolomé Bay, Lower California.

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[1] *Crassopleura* Monterosato, Nomen. Gen. Spec. Medit., p. 127, 1884, type (by monotypy) *Pleurotoma maravignæ* Bivona, 1838, + *Pleurotoma incisa* Reeve, 1843.

Pleistocene: Lower San Pedro series of San Pedro, Los Angeles Co., Calif. (Arnold).
Living: Monterey to Mazatlan, Mexico (Dall).

This species is distinguished by its sculpture and by the uninflected curve at the base of the body whorl. It usually has a strong callus at the top of the inner lip, but otherwise the posterior notch is like that of *Clavatula.* Specimens with more numerous riblets and more prominently sculptured sutural band are usually assigned to the typical variety.

Clavus (Crassispira) montereyensis (Stearns) variety **amathea** (Dall)

"*Drillia pudica* Hinds," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 208, pl. 8, fig. 13, 1903.
Crassispira amathea Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 27, pl. 6, fig. 2, 1919.
Crassispira eurynome Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 21, pl. 7, fig. 5, 1919 (young).

Shell like that of the typical variety but with fewer ribs, narrower spire, and less prominent sutural band.

Type specimens: In the U. S. National Museum, *amathea* No. 56,099, *eurynome* No. 59,345.

Type locality: Of both names, Acapulco, Mexico.

Pleistocene: Upper San Pedro series of San Pedro (Arnold).
Living: Acapulco, etc.

Specimens are usually assigned to this variety when worn. The range and distribution are within those of the typical variety.

C. pudicus (Hinds), of which *C. impressus* (Hinds) is probably a synonym, belongs to the subgenus *Cymatosyrinx.* It is living in Panama.

Clavus (Crassispira) sp.

Plate 26, Figure 10

A fragmentary specimen belonging to the subgenus *Crassispira*, larger than *montereyensis* and with finer sculpture, but not sufficiently well preserved to describe as a new species, was found at loc. 217*b* S. D. S. N. H. in the middle Pliocene of Holser Canyon, Los Angeles Co. It is somewhat like *rugitectus* (Dall),[1] which in turn is somewhat like *bottæ* and *incrassatus* (Sowerby), 1834, (not preoccupied by Dujardin, 1837). It has the sculpture and shape of *Moniliopsis grippi* Dall, but its incrusted inner lip with the callus patch at the top shows that it belongs to *Clavus.*

Dimensions: Altitude (apex defective), 20 mm.; length of aperture, 9 mm.; diameter of body whorl, 9 mm.

Other species referable to the subgenus *Crassispira* are:

"*Clathrodrillia* (*Moniliopsis*)" *fryei* Weaver and Palmer, 1922, Eocene of Washington.
Crassispira tepocana Dall, 1919,—like *bottæ.*
"*Clathrodrillia*" *castianira* Dall, 1919,—young of *tepocanus ?*
Crassispira ? martinensis Dall, 1919,—similar to *montereyensis.*
Crassispira nephele Dall, 1919,—ditto.
Crassispira candace Dall, 1919,—ditto.
Crassispira bacchia Dall, 1919,—more carinate.
Crassispira dirce Dall, 1919,—still more carinate.
"*Drillia*" *appressa* Carpenter, 1864, figured by Dall, 1919.

The species referred by Dall to the section *Carinodrillia*, with the exception of the type, together with the species referred to it by Woodring, probably belong in the subgenus *Clathrodrillia* rather than here. The type of *Carinodrillia* appears to belong with *Suavodrillia* in *Clavatula, sensu lato*, and is probably related to the subgenus *Knefastia.*

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[1] *Turris (Crassispira) rugitecta* Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 226, 1918.
Crassispira ? rugitecta Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 26, pl. 7, fig. 6, 1919.

Subgenus **BRACHYTOMA** Swainson, 1840

Brachytoma Swainson, Treat. Malac., pp. 154, 314, 1840, original list consisting of the two species: (1) *Pleurotoma strombiformis* G. B. Sowerby, Conch. Man., fig. 381, 1839 [= *Pleurotoma stromboides* J. Sowerby, Gen. Sh., *Pleurotoma*, fig. 4, 1820-25, also figured by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 9, species 71, 1843, and by Tryon, Man. Conch., Vol. 6, p. 176, pl. 10, fig. 58, 1884], and (2) *Brachytoma castanea* Swainson, Chemnitz, figs. 1831, 1482 [Chemnitz, Conchyl. Cab., Vol. 11, p. 114, pl. 190, figs. 1831, 1832, 1795, is *Murex* (*Turris*) *coronata* Chemnitz, the type of *Clavatula;* "fig. 1482" is probably a misprint for 1832, for Vol. 10, p. 208, pl. 155, fig. 1482, 1788, is a *Strombus* sp.]; type designated by Herrmannsen, Ind. Gen. Malac., Vol. 1, p. 121, 1846, and by Gray, Proc. Zool. Soc. London, p. 134, 1847, *Pleurotoma strombiformis* Sowerby; name misspelled by the younger Sowerby *Brachitoma* (*fide* Hermannsen), and by Gray and Tryon *Brachystoma*.

Type (by subsequent designation, Herrmannsen, 1846), *Pleurotoma strombiformis* Sowerby, Recent, Bay of Panama (for references see above).

Shell like that of the typical subgenus, but with a relatively short spire and an elongate aperture, the nodes on the shoulders of the whorls drawn out into short axial costæ.

The type of this subgenus is peculiar because of its elongate aperture and anterior canal, and in this respect resembles *Clavatula;* but in all other characters it is clearly a *Clavus*. Other species grade into *Crassispira*, but they have more shouldered whorls and lack the sculpture on the anal fasciole. *Cymatosyrinx* has a higher spire and a shorter aperture.

Clavus (Brachytoma ?) nigerrimus (Sowerby)

Pleurotoma nigerrima Sowerby, Proc. Zool. Soc. London for 1833, p. 137, April, 1834; Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 12, fig. 102, 1843.

Drillia nigerrima Sowerby, Tryon, Man. Conch., Vol. 6, p. 196 (not the synonymy), pl. 14, fig. 91, 1884; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 208, 1909.

Crassispira nigerrima Sowerby, Dall, Nautilus, Vol. 32, p. 23, 1918.

Crassispira erigone Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 21, pl. 7, fig. 8, 1919.

? Elæocyma abdera Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 12, pl. 4, fig. 5, 1919.

Shell of medium size, spire short, tapering; whorls with a strong, rounded shoulder, the area above concave, unsculptured, that below convex, sculptured by about twelve narrow, distant axial riblets, which are most prominent on the shoulder, where they are sometimes nodose, and die out downward, spiral sculpture of indistinct lines in the interspaces between the ribs, with a few distant, stronger spiral cords on the lower part of the body whorl which pass over and nodulate the ribs; aperture about two-fifths the length of the shell, ovate-elongate, with a strongly armored posterior notch, a moderately long, straight columella, and a short, poorly defined anterior canal.

Dimensions: Altitude, 21 mm.; length of aperture, 9 mm.; diameter of body whorl, 8.5 mm.

Type specimens: Of *nigerrimus*, in the British Museum (?); of *erigone*, No. 212,368, of *abdera*, No. 212,373, in the U. S. National Museum.

Type locality: Of all three names, Panama.

Pleistocene: Magdalena Bay, Lower California (Dall, 1918).
Living: Gulf of California to Ecuador (Dall, 1909).

This species is somewhat intermediate between *Brachytoma* and *Crassispira*. The type of the former is distinguished by its unusually elongate anterior canal. *C.* (*Crassispira*) *tepocanus* (Dall) is distinguished by its more numerous ribs, its weaker shoulder, and the spiral sculpture on the anal fasciole.

Subgenus **DRILLIA** Gray, 1838

Drillia Gray, Ann. and Mag. Nat. Hist., Vol. 1, p. 28, 1838, only four species included, *umbilicata* Gray, *clathrata* Gray, *bicolor* Gray, *suturalis* Gray; Proc. Zool. Soc. London, p. 134, 1847, type not cited; Cossmann, Ann. Soc. Roy. Malac. Belgique, Vol. 24 (Ser. 4, Vol. 4), p. 273, 1889, type cited *Drillia umbilicata* Gray; Ess. Paléo. Comp., Vol. 2, p. 82, 1896; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 317, 325, 1918; Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, p. 203, 1925; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 148, 1928.

Type (by subsequent designation, Cossmann, 1889), *Drillia umbilicata* Gray, described by Gray, 1838, illustrated by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 11, fig. 97, 1843, and by Tryon, Man. Conch., Vol. 6, p. 179, pl. 11, fig. 82, pl. 30, fig. 78, 1884.

Shell like that of the typical subgenus but smaller, with only a few, short, very coarse axial riblets extending downward below the anal fasciole, riblets crossed by fine spiral lines; anal fasciole concave.

Distribution: Tropical Atlantic.

C. hexagonus (Sowerby), illustrated by Reeve and Tryon, from Central America, appears to belong to this subgenus also. This group is a peculiar specialized derivative of the more normal forms of the genus; but until it was discovered that *Clavus* was an earlier name for the genus, all of the forms were appropriately assigned to *Drillia*, the oldest name for the genus as then known. Now only the type and perhaps a few others belong to *Drillia*, and apparently none of them is represented in the California region. *Drillia* is related to *Bellaspira*, which might also be considered a subgenus of *Clavus*.

Thiele found that *umbilicatus* (Gray) has a radula like that of *Spirotropis*, with which he classes it accordingly. He also thinks that *Clavus* and *Cymatosyrinx* have a similar radula, but that the radula of *Crassispira* is different and that therefore this group is unrelated. The writers believe that the *Spirotropis-Drillia* radula, having all the rows of teeth represented, is the primitive type for the family, that its presence in various branches of the family does not necessarily indicate any closer relationship, and that on the other hand, groups of greater or smaller size in various branches of the family, such as *Crassispira*, have lost independently, perhaps recently, part of their teeth.

Genus BELLASPIRA Conrad, 1867

Bellaspira Conrad, Amer. Journ. Conch., Vol. 3, p. 261, 1867; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 162, 1928.

Atoma Bellardi, Bolletino della Società Malacologica Italiana (Pisa), Vol. 1, p. 24, 1875, type (by monotypy) *Atoma hypothetica* Bellardi; Mem. R. Accad. Scienze Torino, Ser. 2, Vol. 29, p. 324, 1878, type illustrated; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 126, 1896, type illustrated, pl. 7, fig. 17, Miocene of Italy; not *Atoma* Latreille in Cuvier, Règne Anim., Vol. 3, p. 125, 1817.

Hædropleura (Monterosato MS.) Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 110, 1883, type (by monotypy), *Murex septangularis* Montagu, figured, pl. 14, figs. 26, 27, described by Montagu, Test. Brit., p. 268, pl. 9, fig. 5, 1803, illustrated by Tryon, Man. Conch., Vol. 6, p. 223, pl. 21, fig. 8, 1884, and by Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 251, pl. 27, fig. 27, pl. 29, figs. 3, 4, 1915, Pliocene to Recent from Great Britain to the Mediterranean; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 92, 1896, type illustrated, pl. 6, figs. 14, 15.

Type (by monotypy), *Mangelia virginiana* Conrad, described and figured by Conrad, *loc. cit.*, and pl. 21, fig. 12, originally described in the Proc. Acad. Nat. Sci., Phila., p. 286, 1862; Miocene of Yorktown, Virginia.

Shell small; whorls sculptured with longitudinal ribs of a small or moderate number, otherwise practically smooth; aperture from a third to two-fifths the length of the shell, with a small, indistinct posterior sinus, a small callus patch at the top of the inner lip, a short columella, and a very short, undefined, notched anterior canal; animal operculate.

Geologic range: Miocene to Recent (Europe and America).

Distribution: Europe; west coast of Panama.

This genus is intermediate between *Mangelia*, subgenus *Bela*, and *Clavus*. It is smaller than the latter, with a weaker notch. Dall described a *Bellaspira melea*[1] from Panama, but his "*? Hædropleura*" *melita* apparently does not belong here.

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[1] *Bellaspira melea* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 29, pl. 19, fig. 8, 1919.

Genus MANGELIA Risso, 1826

Mangelia Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 219, 1826, list includes *costulata* Risso (not figured), *ginnania* Risso (fig. 99), *striolata* Risso (fig. 101), *menardiana* Risso (fig. 130), and others, some of which were identified by Gray as *Rissoina;* Herrmannsen, Indicis Generum Malacozoorum, Primordia, Supplement, p. 80, 1852, type cited *M. striolata* Risso (*fide* Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 177, 1928).

Mangilia Risso emended, spelling used by many authors.

Vielliersia Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 128, 1884, type (by monotypy) *Pleurotoma vielliersi* [*sic*] Michaud, Bull. Soc. Linn. Bord., p. 202, pl. 1, figs. 4, 5, 1829, Mediterranean, with "*Raphitoma attenuata* Montagu," Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 101, pl. 14, fig. 24, 1883, cited by Monterosato in the synonymy.

Villiersiella Monterosato, Nat. Sicil., An. 9, p. 191, 1890, new name for *Villiersia* (the original spelling said to be a typographical error, though the specific name was spelled the same way); not *Villiersia* Orbigny, 1837.

Type (by subsequent designation, Herrmannsen, 1852), *Mangelia striolata* Risso, *op. cit.*, p. 221, pl. 8, fig. 101, 1826, living and "subfossil" in the Mediterranean, = *Pleurotoma villiersii* Michaud, Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 80, pl. 27, figs. 1, 1840, = *Murex attenuatus* Montagu, Testacea Britannica, p. 266, pl. 9, fig. 6, 1803. Risso's and Kiener's illustrations are reproduced below, though not very clearly, on plate 25, figures 18 and 19*a*, 19*b*.

Shell small, thin, elongate, strengthened with a few distant axial ribs which are crossed by many fine spiral striations; aperture narrow, elongate, outer lip thickened when in the process of forming a rib, sometimes with a single denticle near the upper part separating off an embayment-like posterior notch, lip thin when growing between ribs, with then but a small, rounded, slit-like notch, in species that do not have strong axial ribs the posterior notch sometimes merely a rounded embayment, sometimes practically obsolete, inner lip smooth, columella nearly straight, moderately long, anterior canal usually not well defined, short, not notched behind; animal (always ?) inoperculate.

Geologic range: Eocene to Recent.

Distribution: All temperate and tropical waters.

The nomenclature of this important genus of little shells has been needlessly confused. Dall's statement[1] that Bellardi selected *M. costulata* as the type in 1847 seems to be entirely unfounded, for in his Monograph of the Fossil Pleurotomas of Piedmont Bellardi[2] notes the name only in the synonymy. It is possible that Bellardi wrote something else in that year; but as Dall gives no reference to it and as no other reference could be found, it must be regarded for the time being as mythological. However, even if *costulata* had been cited as the type, it would only cause a reorganization of the subgenera within the genus; for *costulata* Risso, figured by Kiener,[3] is surely congeneric with *striolata*, even if it is the same as *nebula*, the type of *Bela*, as Dall says it is. Therefore, unless more evidence is produced that will lead to some other conclusion, *striolata* Risso, 1826, (not of Scacchi, 1836) must be accepted as the type.

Furthermore, there need be no question about the character of the species *striolata*, for it will be evident to anyone who compares Risso's figure with Kiener's excellent illustrations of *villiersii* that they represent the same species. Also, a comparison with Montagu's original figure of *attenuata* will show almost as certainly that it too represents the same species, although some later writers have misidentified *attenuata*. The name *Mangelia*, then, may be considered fixed.

The limits of the genus *Mangelia* are open to debate. Border-line species are difficult to separate from *Lora*, *Cythara*, *Clathurella*, *Pleurotomoides*, and the young of *Clavus*. In addition, the genus itself varies into such a number of different forms that it is difficult to keep track of them all. Typical *Mangelia* has a thin, elongate shell with only a small number of axial costæ, crossed by many minute spiral lines. Its posterior notch varies according to the stage of growth, being at the time of the formation of one of the varix-like ribs (the form illustrated by Risso and Kiener) like that of the subgenus *Agathotoma;* but, when growing between ribs, more like that of the subgenus *Bela* and its section *Kurtziella.* The typical group varies into *Bela,* which has a somewhat heavier shell, a somewhat shorter aperture, less distant axial ribs, stronger spiral lines, and a simple outer lip with an unemphasized posterior notch. The subgenus *Mitromorpha* grades from the *Agathatoma*-like species of *Bela* into a form with biconic shape, occasionally having denticles on the inside of the outer lip. The typical group also varies into *Agathotoma,* which has broader, more wave-like axial ribs covered with numerous, more prominent, though still fine, spiral threads, a much shorter anterior canal, and a posterior notch that sinks deeply into the thickened edge of the outer lip. The section *Pseudoraphitoma* has a high spire and a row of denticles on the inside of the outer lip in addition to the fold that occurs sometimes in typical *Mangelia* just below the notch.

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[1] *Mangilia* Risso, Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 316, 1918.

[2] Mem. R. Accad. Scienze Torino, Ser. 2, Vol. 9, pp. 531-650, 1847.

[3] *Pleurotoma costulata* Risso, Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 78, pl. 25, figs. 2, 1840.

Mangelia is a warm or temperate water genus, whereas *Lora* is typical of cold waters. All of the species from the Alaskan region that have been assigned to *Mangelia* are open to question, and according to their shell characters should probably be assigned to *Lora,* whether with or without an operculum. *Lora* can usually be distinguished by its larger size, its greater relative breadth, its more numerous axial ribs, and its stronger spiral lines. Also, the aperture is usually more open, and the posterior notch weaker, shallower, and farther from the suture. The intergradation between *Mangelia* and *Lora* may be more apparent than real, for the two may be adaptations of different branches of the family to analogous environmental conditions.

On the other hand, the intergradation between *Mangelia* and the genera *Cythara, Clathurella,* and *Raphitoma* is probably real. *Cythara* is like *Agathotoma* except that it is larger, has a heavier shell, a short, blunt spire, and numerous teeth on both sides of its long, narrow, nearly straight aperture. *Clathurella* is like *Agathotoma* except that it is larger, has a blunter spire, coarse rounded axial ribs, and a few strong teeth on the inside of the outer lip. *Raphitoma* is like *Agathotoma* except that it is larger, has more rounded whorls with sharp reticulate sculpture, and at certain growth stages faint teeth on the inside of the outer lip.

The subgenus *Bela* is related closely to *Clavus* through the small species of *Cymatosyrinx.* Indeed, some of the young of small species of *Cymatosyrinx,* like *C.* (*Cymatosyrinx*) *thalea* (Dall) from Florida, can hardly be distinguished from *M.* (*Bela*) *nebula* until the former becomes large enough to develop the callus patch at the top of the inner lip and to show its deeper anterior and posterior notches. *Bellaspira,* with its probable synonym *Hædropleura,* is intermediate in some respects between *Bela* and *Cymatosyrinx,* having a larger, heavier, and coarser shell than *Bela,* a callus on the inner lip, and an operculum; but it is smaller than a normal *Cymatosyrinx* and has a shallow posterior notch.

Subgenus **MANGELIA**, s. s.

Shell thin, elongate; whorls sculptured with a few narrow, distant axial ribs, spirally marked with fine lines; aperture elongate, narrow, outer lip at some stages of growth thickened by a rib, the posterior notch rounded, not very deep, sometimes emphasized by a fold or denticle situated just below it on the inside of the outer lip, at other stages of growth outer lip thin, the notch small, rounded, of variable depth, not emphasized by a fold, columella nearly straight, anterior canal not well defined, merely an elongation of the narrow aperture, fairly long, not notched behind; animal inoperculate.

Mangelia (Mangelia) hexagona Gabb

Mangelia hexagona Gabb, Proc. Calif. Acad. Sci., Ser. 1, Vol. 3, p. 185, 1865; Berry, Nautilus, Vol. 21, p. 40, 1907.
Mangilia (*Cythara*) *branneri* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 211, pl. 9, fig. 10, 1903.
Mangilia hexagona Gabb, Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, 1916.
Cytharella hexagona Gabb, Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 145, 1927.
Cytharella branneri Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.
Cytharella (*Agathotoma*) *quentinensis* Dall, West Amer. Scientist, Vol. 19, no. 3, p. 21, 1921.
Agathotoma quentinensis Dall, Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 2, pl. 8, fig. 1, 1925.

Shell small, thin, very elongate; whorls sculptured with six fairly sharp, strong ribs, nearly straight, continuous up the spire, ribs and interspaces crossed by very minute spiral lines; aperture varying in length from one-third to two-fifths the length of the shell, elongate, outer lip very thin except when forming a rib, posterior notch nearly obsolete, columella nearly straight, anterior canal not defined, merely an elongation of the aperture, moderately wide, very, very slightly notched or sometimes bent backward.

Dimensions: Altitude, 9 mm.; length of aperture, 3.4 mm.; diameter of body whorl, 2.6 mm.

Type specimens: Of *hexagona*, locality unknown; of *branneri*, No. 162,552, of *quentinensis*, No. 333,134, in the U. S. National Museum.

Type localities: Of *hexagona*, "one specimen from Catalina Island, 40 fms., another from the beach at Monterey;" Oldroyd, 1927, selects the first locality; of *branneri*, lower San Pedro Pleistocene of Deadman Island, Calif.; of *quentinensis*, "? Pliocene" of San Quintin Bay, Lower California.

Upper Pliocene: "Pleistocene" at Bath-house Beach, Santa Barbara (Arnold); Fourth and Broadway, Los Angeles (Moody).
Pleistocene: Lower San Pedro series of Deadman Island (Arnold), of Nob Hill cut, San Pedro (T. S. Oldroyd), Los Angeles Co., Calif., common; San Quintin Bay, Lower California (Dall; Jordan).
Living: Monterey to San Diego; Panama (Dall).

This species is easily distinguished by its six sharp, distant, longitudinally connected ribs, and to the naked eye otherwise smooth surface. It is more elongate and has finer spiral and sharper axial sculpture than *aculea* Dall. Gabb's dimensions show that his shell had a slightly longer aperture than *branneri* or *quentinensis*, and one small living specimen in the Oldroyd Collection at Stanford University agrees. Nevertheless, most of the living specimens have the shorter aperture, and the writers believe this character to be but an individual variation.

Mangelia (Mangelia) merita (Hinds)

Clavatula merita Hinds, Proc. Zool. Soc. London, p. 42, 1843; Zool. Voy. *Sulphur*, Moll., pl. 6, fig. 20, 1844.
Pleurotoma merita Hinds, Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 18, species 148, December, 1843.
Clathurella merita Hinds, Tryon, Man. Conch., Vol. 6, p. 280, pl. 18, fig. 32, 1884.
Cytharella ? janira Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 76, pl. 21, fig. 10, 1919.
Cytharella amatula Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 78, pl. 21, fig. 2, 1919; Bull. 112 U. S. Nat. Mus., p. 82, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 147, 1927.
Cytharella merita Hinds, Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 147, 1927.
Cytharella (*Agathotoma*) *janira* Dall, Bull. 112 U. S. Nat. Mus., p. 83, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 148, pl. 19, fig. 7, 1927.

Shell of medium size and weight, fusiform; whorls strongly convex or with an obtuse angle on the upper part, sculptured with nine to eleven broad, rounded axial riblets, crossed by numerous fine spiral threads and grooves, the thread on the angle usually a little stronger and in living specimens sometimes colored brown, aperture of variable length, usually about half the length of the shell, narrow, lenticular, outer lip thickened by a rib or thin according to the growth stage, posterior notch also varying according to the growth stage, at times very shallow, at other times deep and narrow but not reinforced, inner lip resorbed, columella elongate, anterior canal merely an elongation of the aperture.

Variety **merita**, s. s.

Shell comparatively short.
Dimensions: Altitude, 11 mm.; length of aperture, 5.5 mm.; diameter of body whorl, 4.2 mm.

Type specimens: Of *merita*, in the British Museum (?); of *janira*, No. 55,285, of *amatula*, No. 127,534*a*, in the U. S. National Museum.

Type localities: Of *merita*, Gulf of Nicoya, Central America; of *janira* and *amatula*, San Diego.

Distribution: Monterey to the Gulf of Nicoya.

Mangelia (**Mangelia**) **merita** (Hinds) variety **painei** Arnold

Mangilia painei Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 214, pl. 8, fig. 1, 1903; not "*Mangilia painei* Arnold," Dall, 1919.

Shell comparatively elongate, with a relatively longer columella and anterior canal, whorls without angulation.
Dimensions: Altitude, 12 mm.; length of aperture, 6.1 mm.; diameter of body whorl, 4.2 mm.

Type specimen: No. 162,530 in the U. S. National Museum.

Type locality: Lower San Pedro Pleistocene of Deadman Island, San Pedro Harbor, Los Angeles County.

Pleistocene: Type locality.

Living: Specimens in the Oldroyd Collection at Stanford University from Monterey and San Diego.

The variety *painei* is one extreme among a number of others equally distinct that terminate the several series of variations in this rather variable species. Living examples that agree in every essential with Arnold's illustration and description of *painei* are to be found in the Oldroyd Collection at Stanford University under various labels. Other variations appear in the collection, one with stronger tabulation and more glistening surface labeled *hamata* Carpenter, one with a heavier shell labeled *fusconotata* Carpenter (this form described originally as a *Cithara*), and another included under the label *amatula* Dall with a short aperture and a higher spire. The last may be the form described under the name *Mangilia* (*Kurtziella*) *hebe* Dall, 1919, the illustration of that form showing an individual in the interrib growth stage. The writers did not have sufficient material to determine the proper application of Carpenter's names.

The species *merita* forms a link between *Mangelia*, *s. s.*, and *Agathotoma*, resembling the latter in some respects more closely. It is quite distinct from *hexagona*, having a less elongate shell with more numerous, more rounded, less distant axial ribs not continuous up the spire, and in the rib-forming growth stage with a more distinctly thickened outer lip. It is to be noted that both in *Agathotoma* and in *Mangelia*, *s. s.*, the ribs when few in number tend to be continuous up the spire, but when more numerous they more often become irregular. This species is assigned to typical *Mangelia* instead of to *Agathotoma* because the outer lip is thickened only part of the time and then not strongly, and because the columella is longer than is usual for *Agathotoma* and the ribs more rounded than wave-like. In the growth stages when the notch is shallow this species might be mistaken for a species of the subgenus *Bela*, such as the higher-spired variations of *hecetæ*. *M. merita* is a strong argument for not separating the subgenera of *Mangelia* into distinct genera.

Subgenus **BELA** Leach in Gray, 1847

Bela Leach, Gray, Ann. and Mag. Nat. Hist., Vol. 20, p. 270, 1847, species in the original list are *nebula, rufa, cranchii, minima, septangularis* and *attenuata*, all of Montagu; Proc. Zool. Soc. London, p. 134, 1847, type designated, *Murex nebula* "Montf." (probably a misprint for Montagu); Iredale, Proc. Malac. Soc. London, Vol. 11, p. 297, 1915; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 318, 1918; Woodring, Carnegie Inst. Wash., Publ. No. 385, pp. 178, 179, 1928.

Not "*Bela* Gray," as used erroneously by many authors for *Lora*, the error pointed out by Harris, Iredale, and others (see *Lora*).

Cytharella Monterosato, Boll. Società Malacologica Italiana (Pisa), Vol. 1, p. 73, 1875, type (by monotypy) *Murex costatus* Donovan, Nat. Hist. Brit. Shells, Vol. 3, pl. 91, January, 1802, well described and illustrated by Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 485, pl. 114A, figs. 3, 4, 5 (in Vol. 4), pl. RR, fig. 4 (animal, —in Vol. 1), 1853; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 168, 1928.

Mangiliella, Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 108, 1883, type (by monotypy) *Pleurotoma multilineolata* Deshayes, figured by B., D., and D., *op. cit.*, pl. 15, figs. 23, 24, 25, also by Cossmann, Ess. Paléo. Comp., Vol. 2, p. 119, pl. 7, fig. 13, 1896, Mediterranean.

Ginnania Monterosato, Nom. Gen. Spec. Conch. Medit., p. 127, 1884, type (by absolute tautonymy) *Pleurotoma fuscata* Philippi, of which Monterosato said, "Designata col nome di *Ginnania*, Risso (sp. dubbia); *Ginannia* Sc.; *Ginnanianum*, Ph., e riferita alla *nebula*, Mtg., forma dei mari del Nord." Monterosato evidently didn't agree that *fuscata* should be referred to *nebula*, for he cites in the synonymy of *fuscata* "*Raphitoma nebula*, (non Mtg.) B., D. e D.," Moll. Mar. Roussillon, Vol. 1, "pl. 14, figs. 22, 23," 1883.

Smithia Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 128, 1884, type (by monotypy) *Pleurotoma striolata* Scacchi (not Risso) with *P. costata* (*non* Pennant) Blainville, Faune Franc., p. 103, pl. 4, fig. 6 (Medit.), and *P. smithii* Forbes (Britain) listed in the synonymy, species illustrated by Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 483, pl. 114A, figs. 1, 2 (in Vol. 4), 1853, and *smithii* Forbes, Ann. [and Mag.] Nat. Hist., Vol. 5, p. 107, pl. 2, fig. 14, 1840, also by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 35, species 320, 1846; not *Smithia* Edwards and Haime, 1851, nor Maltzan, 1883.

Smithiellia Monterosato, Nat. Sicil., An. 9, p. 186, May 1, 1890, new name for *Smithia;* Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, p. 766, 1898; Iredale, Proc. Malac. Soc. London, Vol. 13, p. 32, 1918; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 331, 1918.

Smithiella Monterosato, Kobelt, Icon. Eur., Vol. 3, p. 381, 1905.

Not "*Cytharella* Monterosato" Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 320, 325, 1918, etc., type *Pleurotoma bertrandi* Payraudeau, not in Monterosato's original list (Dall's reference to p. 6 is to a separate of Monterosato's paper); = *Agathotoma.*

Type (by subsequent designation, Gray, 1847), *Murex nebula* Montagu, fossil in the Red Crag and living from the North Sea to the Mediterranean, illustrated by Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 476, pl. 114, figs. 7, 8, 9 (in Vol. 4), pl. RR, fig. 7 (animal, — in Vol. 1), 1853; by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 23, species 198, 1845 (poor figure); and by Tryon, Man. Conch., Vol. 6, p. 307, pl. 21, figs. 21, 10, pl. 30, fig. 86, pl. 33, fig. 56, 1884.

Shell like that of the typical subgenus, but slightly heavier, with less distant axial ribs, the ribs not always continuous up the spire, sometimes low, rounded, or curving, whorls sometimes angulated, posterior notch usually weak.

This subgenus is closely related to the typical subgenus, with which it intergrades in Europe; but it is fairly distinct on the California coast, where the typical subgenus is poorly represented. It intergrades also with the subgenus *Agathotoma;* and the borderline species that have a shorter anterior canal and a slightly thickened outer lip are assigned arbitrarily to *Agathotoma*. *Bela* bears a superficial resemblance to some small Pyrenids, especially *Aesopus* and *Chauvetia,* but the latter lack the posterior notches, have a twisted columella or a notched anterior canal and an operculum. The elongate, round-whorled species are included in the section *Bela, s. s.;* the elongate, angulated species in the section *Kurtziella;* and the broader, *Lora*-like species in the section *Ishnula.*

Section Bela, s. s.

Shell high spired, with rounded whorls and low, rounded ribs.

Mangelia (Bela) variegata Carpenter

Mangelia variegata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 658, 1864; Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 394, 1865; descriptions reprinted in Smithsonian Misc. Coll., No. 252, pp. 144, 284, 1872.

Mangelia (*? variegata*, var.) *nitens* Carpenter, same references.

"*Daphnella interfossa* Carpenter," Tryon, Man. Conch., Vol. 6, p. 310, pl. 22, fig. 57, 1884.

"*Mangilia striosa* C. B. Adams," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 215, pl. 9, fig. 3, 1903.

Mangilia oenoa Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 66, pl. 8, fig. 6, 1919 (young); Bull. 112 U. S. Nat. Mus., p. 81, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 138, 1927.

Cytharella (*Agathotoma*) *densilineata* Dall, Bull. 112 U. S. Nat. Mus., p. 83, 1921, new name for "*striosa*" Arnold; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 149, 1927.

Mangilia pulchrior Dall, Bull. 112 U. S. Nat. Mus., pp. 81, 201, 1921, new name for *nitens* Carpenter "not Sowerby," new name not necessary, for there is no *nitens* Sowerby and the only prior *nitens* is *Clavatula nitens* Hinds, which is clearly a *Clavus* (*Cymatosyrinx*), not a *Mangelia;* Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 139, 1927.

Shell high spired, thin; whorls moderately rounded or very slightly angulated at the upper part, sculptured with nine to fifteen narrow, somewhat curved axial ridges crossed by numerous fine spiral striations, the ribs on the body whorl being fewer and more rounded than those of the spire; aperture lenticular, elongate, about two-fifths the length of the shell, outer lip thin, posterior notch a shallow, arcuate sinuosity in the edge of the outer lip just above the point of greatest convexity of the whorl, best shown by the curvature of the axial ribs, columella only very slightly flexuous, anterior canal moderately long, not defined, not notched behind; living shells with one (or two) narrow color bands about the middle of the body whorl.

Dimensions: Altitude, 10 mm.; length of aperture, 4 mm.; diameter of body whorl, 3.3 mm.

Type specimens: Of *variegata* and *nitens* (+ *pulchrior*), in the British Museum (?); of *densilineata*, at Stanford University (?); of *oenoa*, No. 153,051 in the U. S. National Museum.

Type localities: Of *variegata* and *nitens*, Santa Barbara, living; of *densilineata*, "upper San Pedro" Pleistocene of Los Cerritos, Los Angeles Co., Calif.; of *oenoa*, San Pedro, living.

Pleistocene: Type locality of *densilineata* (Arnold), also from San Diego (Arnold); Santa Monica (Oldroyd Collection at Stanford University); upper Pleistocene of San Quintin Bay, Lower California (Jordan).

Living: Monterey, Calif., to the Gulf of California.

The name *variegata* is not preoccupied by *Pleurotoma variegata* Kiener, which is a *Turricula* over three inches long, nor by "*Pleurotoma variegata* Kiener" Reeve, which is a typical *Turris*, nor by *Pleurotoma variegatum* Philippi, which is a *Raphitoma*, a synonym or variety of *purpurea* (Montagu). Also, it appears, as noted in the synonymy, that Carpenter's varietal name is still good. Hence, unless new instances of the use of these names are found, there is no need for Dall's 1921 substitute names.

Unfortunately, the identification of the older names is uncertain, for Carpenter's descriptions are brief and rather unsatisfactory, and there are no figures. It is hoped that some day the types can be found and made known. Apparently Carpenter's types were young, unusually narrow shells, the length being over three times the breadth; and the type of *variegata* is described as having only nine axial ribs, whereas most specimens have more. In the Oldroyd Collection at Stanford University there is one specimen with ten ribs on the body whorl, several with eleven, and the normal number seems to be twelve. Nearly all the specimens have more ribs on the penultimate whorl than on the body whorl, though the number is less again on the early whorls. Thus it is that Dall's type of *oenoa*, which is an immature shell, has an unusually large number of ribs. Occasionally a specimen will retain its numerous ribs even on the last whorl, apparently never reaching a gerontic stage. In other respects the forms here included under the name *variegata* agree very well with one another and with Carpenter's descriptions, even to the matter of color markings; and as the number of ribs has been shown to be a very variable character in this species, it is considered most probable that Carpenter had an unusual variation with the minimum number of ribs. It is interesting to note that he mentions having other specimens with more numerous ribs. The variety *nitens* does not appear to be distinguishable.

An interesting observation was made on the protoconch of this species. Nearly all of about a dozen specimens examined had two or two and a half smooth, rounded, bulging whorls. One specimen, however, had all but a very small, depressed first whorl spirally striated, and these striations were crossed by rudimentary axial irregularities. This odd specimen contrasted very strikingly with the others, and the writers began to speculate about the value of protoconchs for making generic and specific separations when another specimen was discovered that provided the explanation. Most of its protoconch was smooth as in the majority of the others, but near the suture in places that had been partly protected from wear were remnants of the almost entirely removed outer layer.

Mangelia (Bela) hooveri Arnold

Mangilia hooveri Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 212, pl. 9, fig. 5, 1903; Dall, Bull. 112 U. S. Nat. Mus., p. 80, 1921.

Like the last, but with low, broad, rounded ribs, nearly straight, about ten to a whorl.
Dimensions: Altitude, 10.9 mm.; length of aperture, 4 mm.; diameter of body whorl, 3 mm.

Type specimen: No. 162,531 in the U. S. National Museum.

Type locality: Upper San Pedro series, Pleistocene, of San Pedro, California.

Pleistocene: Type locality (Arnold); San Diego (Dall).

This form may be a variety of *variegata;* or perhaps it is the typical form of *variegata,* and *oenoa* and *densilineata* are a variety with more numerous ribs. The forms vary in the shape and in the number of ribs, and it is a question which character, if either, is significant. Probably *hooveri* should not be regarded as an extinct species.

Mangelia (Bela) perattenuata Dall

Columbella (*Aesopus*) *oldroydi* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 238, pl. 6, fig. 7, 1903, not *Mangilia oldroydi* Arnold, *op. cit.*, p. 213, pl. 6, fig. 16 (= *? Lora declivis* var. *ecarinata* Sars, which see).
Ma(n)gilia perattenuata Dall, Nautilus, Vol. 18, p. 123, 1905; Proc. U. S. Nat. Mus., Vol. 56, p. 65, pl. 20, fig. 11, 1919; Bull. 112 U. S. Nat. Mus., p. 81, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 139, 1927.
Mangilia cetolaca Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 286, 1908; new name for *Aesopus oldroydi* Arnold; Bull. 112 U. S. Nat. Mus., p. 80, 1921.
Philbertia (*Nannodiella*) *phylira* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 60, pl. 20, fig. 6, 1919, young.
Philbertia (*? Nannodiella*) *amycla* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 61, pl. 20, fig. 8, 1919, younger.

Shell small, very elongate; whorls not very convex, early whorls sculptured with ten to fifteen narrow, distant axial riblets, their number increasing on each succeeding whorl, and with one to three similar, sharp, distant spiral riblets, their number also increasing with the growth of the shell, ribs and spirals nodulous where they cross, sculpture nearly obsolete in adult specimens and the delicate sculpture of the earlier whorls usually almost obliterated by wear; aperture short, narrow, less than a third the length of the shell, outer lip thin, simple, posterior notch weak, merely a waving of the growth lines above the uppermost spiral, columella short, sliced off obliquely at varying angles near the end, anterior canal short, not defined.
Dimensions: Altitude, 8 mm.; length of aperture, 2.3 mm.; diameter of body whorl, 2.3 mm.

Type specimens: All in the U. S. National Museum except that of *cetolaca,* which cannot be found; that of *phylira,* No. 274,108, that of *amycla,* No. 216,944.

Type localities: Of *perattenuata*, living, Monterey Bay; of *cetolaca*, lower San Pedro, Pleistocene, of Deadman Island, Los Angeles Co., Calif.; of *phylira*, Panama; of *amyela*, Panama.

L. Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles Co. (Arnold).
Living: Monterey to Panama.

This species has received a large number of names because of its different appearance when young; but there is in the Oldroyd Collection at Stanford University a series of specimens from Lower California showing the different growth stages, and on one nearly adult specimen the early sculpture is almost all preserved. Dall mentions that *phylira* "superficially resembles '*Aesopus*' *oldroydi* Arnold," but the resemblance is more than superficial. Dall compares this species to *Mangelia constricta* Gabb, a species from Catalina Island that has never been figured,[1] but the latter has a shorter shell and a deeper notch. The species of *Nannodiella* to which Dall compares the young forms have smaller shells than the young of *perattenuata*, with deeper notches showing in the growth lines of the spire whorls, and stronger angulations; and even without the apertures they would be recognizably different. *M. perattenuata* is most closely related to *M. variegata* and *M. hooveri*, but it has a slenderer shell and a different sculpture.

Mangelia (Bela) interlirata Stearns

Mangelia interlirata Stearns, Proc. Calif. Acad. Sci., Vol. 4, p. 226, pl. 1, fig. 10, 1872; Baker, Nautilus, Vol. 16, p. 41, 1902.

Mangilia interlirata Stearns, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 213, pl. 6, fig. 15, 1903; Dall, Bull. 112 U. S. Nat. Mus., p. 81, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 143, 1927.

Mangilia interfossa var. *pedroana* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 213, pl. 6, fig. 3, 1903; Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921.

Mangilia cesta Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 71, pl. 21, fig. 7, 1919; Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 137, 1927.

Shell small, elongate; whorls moderately rounded, sculptured by eight to ten strong, rounded axial ribs with wider interspaces and by ten to twelve revolving grooves also with wider interspaces, the grooves showing only between the ribs and on the lower part of the body whorl; aperture short, about a third the length of the shell, rounded at the posterior end, with a shallow posterior notch, aperture wider anteriorly, outer lip slightly thickened at the rib stage, columella straight, canal not defined.

Dimensions: Altitude, 9 mm.; length of aperture, 3 mm.; diameter of body whorl, 3 mm.

Type specimens: In the U. S. National Museum, that of *pedroana* No. 162,532, that of *cesta* No. 209,040; for *interlirata*, *fide* Oldroyd.

Type localities: Of *interlirata*, Monterey Bay; of *pedroana*, lower San Pedro Pleistocene of Deadman Island; of *cesta*, San Pedro.

U. Pliocene: Santa Barbara (Arnold).
Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles Co. (Arnold); upper San Pedro series of Los Cerritos, Los Angeles Co. (Arnold).
Living: Monterey to Catalina Island, California.

This species resembles the typical subgenus in sculpture, but has a heavier shell and shorter aperture. It has stronger sculpture than *perattenuata* and a shorter aperture and columella than *variegata*. Its short columella is more like that of *Agathotoma*, but it does not have the wave-like ribs nor the heavy outer lip of the latter. It resembles *M. crassaspera* and its relative *rhyssa*, but the more numerous spiral lines do not cross the ribs, and it has a higher spire than *crassaspera*. The form figured by Arnold as *interlirata* has an unusually small number of ribs.

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[1] *Mangelia constricta* Gabb, Proc. Calif. Acad. Sci., Ser. 1, Vol. 3, p. 84, 1865.

? Section ISHNULA Clarke in Gray, 1847

Ishnula Clarke, Gray, Proc. Zool. Soc. London, p. 134, 1847; Iredale, Proc. Malac. Soc. London, Vol. 11, p. 299, 1915; see also *Lora*.

Type (by monotypy), *Mangelia menardiana* Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 222, pl. 9, fig. 130 (explanation of figure on p. 437), 1826, figure reproduced herewith, plate 25, figure 21.

Like the typical subgenus but somewhat angulated and relatively shorter and broader.

Iredale was wrong in stating that "Gray indicated Clarke's name as an absolute synonym" of *Bela*, for Gray named it on a separate line, his method of treating subgenera, and in addition he placed it behind a question mark.

Mangelia (Bela) crebricostata Carpenter

Mangelia crebricostata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 628, 658, 1864; Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 28, 1865; these publications reprinted in Smithsonian Misc. Coll., No. 252, pp. 114, 144, 242 (bottom pagination), 1872.

Mangilia crebricostata Carpenter, Dall and Bartsch, Victoria Memorial Museum, Bull. No. 1, p. 140, pl. 10, fig. 3, 1913; Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921; Oldroyd, Univ. Wash. Puget Sound Biol. Sta., Vol. 4, p. 85, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 145, Pt. 2, pl. 61, fig. 3, 1927.

Mangilia newcombei Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 71, pl. 21, fig. 4, 1919; Bull. 112 U. S. Nat. Mus., p. 81, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 83, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 141, 1927.

Shell of medium size or large for a *Mangelia*, spire moderately high; whorls rounded, with a slight angulation near the top, sculptured with about fifteen flexuous, low, rounded axial ribs, crossed by numerous small spiral lines, which are more prominent in the interspaces; aperture bluntly ovate, less than half the length of the shell, outer lip simple, posterior notch represented by a backward curving of the lip, the deepest point being near the angulation, columella moderately long, slightly sliced off at the end, anterior canal poorly defined, not long; animal inoperculate.

Dimensions: Altitude, 12 mm.; length of aperture, 5.5 mm.; diameter of body whorl, 4.2 mm.

Type specimens: In the U. S. National Museum, that of *newcombei* No. 150,965.

Type localities: Of both, Vancouver district; of *crebricostata*, Neah Bay, Washington (*fide* Oldroyd); of *newcombei*, Clayoquot Sound, Vancouver.

Living: Vancouver to Monterey, California; also Alaska, according to Dall, but this record questioned.

This species resembles somewhat *M. variegata*, but it has a broader shell and stronger ribs. It is strikingly like the type illustration of *Mangelia menardiana* Risso, and for this reason the name *Ishnula* is introduced here, although it is not believed that the sections of *Bela* have any significance, *Kurtziella* being no better than *Ishnula*. *M. crebricostata* is distinguishable from *M. hecetæ* by its curving, more numerous ribs. It very much resembles a small specimen of *Lora pyramidalis*, and the report of this species in Alaska may be a misidentification of a small *Lora*.

Mangelia (Bela) hecetæ Dall and Bartsch

Mangelia angulata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 603, 658, 1864; Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 395, 1865; these publications reprinted in Smithsonian Misc. Coll., No. 252, pp. 89, 144, 284, 1872; Keep, West Coast Shells, p. 55, 1888, 1892; not *Mangelia angulata* Reeve, Conch. Icon., Vol. 3, *Mangelia*, pl. 8, species 62, 1846.

Mangilia angulata Carpenter, Cooper, Bull. No. 4, Calif. St. Mining Bureau, p. 27, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 212, pl. 7, fig. 9, 1903; T. S. Oldroyd, Nautilus, Vol. 28, p. 81, 1914; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 43, 1916; Dall, Bull. 112 U. S. Nat. Mus., p. 79, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Mangilia hecetæ Dall and Bartsch, Canada Dept. Mines, Geol. Surv. Branch., Memoir No. 14-N, p. 10, pl. 1, fig. 6, 1910; Dall, Bull. 112 U. S. Nat. Mus., p. 81, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 84, pl. 12, fig. 6, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 141, pl. 11, fig. 8, 1927.

Mangilia (*Kurtziella ?*) *beta* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 64, pl. 22, fig. 4, 1919, (young).

Compare *Lora antipoda* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 41, pl. 19, fig. 1, 1919.

Mangilia beta Dall, Bull. 112 U. S. Nat. Mus., p. 80, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 136, 1927.

Mangilia barbarensis Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 82, 1924; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 132, September, 1927, new name for *angulata* Carpenter not Reeve.

Shell of medium size, with a moderately high spire; whorls definitely but obtusely angulated near the top, sculptured with 12-14 rather narrow axial ribs, which pass nearly straight across the shelf and fall off almost vertically below the angle, interspaces and sometimes the ribs crossed by numerous very fine spiral lines which are usually not evident to the naked eye; aperture about half as long as the shell, ovate, with the posterior end blunted by the angulation and the anterior end drawn out into a rather narrow but short and poorly defined anterior canal, outer lip thin, the notch coming at the angle or a little above, hardly noticeable; animal inoperculate.

Dimensions: Altitude, 11 mm.; length of aperture, 5.5 mm.; diameter of body whorl, 4.5 mm.

Type specimens: Of *angulata* = *barbarensis*, in the British Museum (?); of *hecetæ*, in the collection of the Canadian Geological Survey at Ottawa (*fide* Oldroyd); of *beta*, No. 206,554, of *antipoda*, No. 209,450, in the U. S. National Museum.

Type localities: Of *angulata* = *barbarensis*, Santa Barbara; of *hecetæ*, Barkley Sound, Vancouver Island; of *beta*, Point Año Nuevo, middle California; of *antipoda*, Magellan Strait, South America.

U. Pliocene: Santa Barbara (Arnold); Fourth and Broadway, Los Angeles (Moody).

L. Pleistocene: Lower San Pedro series of San Pedro and Deadman Island, Los Angeles Co.; Barlow canyon, Ventura Co. (Arnold); "Saugus," Ventura Co. (Waterfall); loc. 233 S. D. S. N. H., north of Arroyo Santa Rosa, Ventura Co., numerous (U. S. G.); loc. 244, Sexton Canyon, Ventura Co., one specimen (U. S. G.); locs. 247, 249, 250, north of Ventura, several specimens (U. S. G.).

U. Pleistocene: Upper San Pedro series of the vicinity of San Pedro (Arnold; T. S. Oldroyd); San Diego (Arnold); San Quintin, Lower California (Jordan); Santa Monica, numerous (Oldroyd Collection); loc. 74, S. D. S. N. H., near Goleta, Santa Barbara Co. (U. S. G.).

Living: Vancouver Island to the Gulf of California.

This common and well-known species has for many years been referred to under the name *angulata*, and it is unfortunate that that appropriate name was preoccupied. *M. barbarensis* was proposed to replace it, but there are at least two earlier names that must be considered ahead of *barbarensis*. Probably Dall and Bartsch did not know that Carpenter and others had reported *angulata* from the Vancouver district, for they say that *hecetæ* does not agree with any species previously described from that region. The South American *antipoda* is here referred to merely to call attention to its striking similarity to *beta*, the young of *hecetæ*.

This species varies considerably in the width of the body whorl and somewhat in the number of ribs. The specimen figured by Arnold has unusually few ribs. The taller variations with weaker angles resemble *variegata* but are larger and broader, with stronger ribs. *M. crebricostata* is distinguished by its weaker angle and curving ribs, but like *variegata* probably intergrades. *M. arteaga* has a sharper angle, sharper sculpture, and a deeper notch. *Lora turricula* variety *popovia* Dall differs only in its stronger spiral sculpture and its operculum.

Section Kurtziella Dall, 1918

Kurtziella Dall, Proc. Biol. Soc. Wash., Vol. 31, p. 137, 1918.

Type (by original designation), *Pleurotoma cerina* Kurtz and Stimpson, Atlantic coast; figured by Tryon, Man. Conch., Vol. 6, p. 310, pl. 22, fig. 43, 1884; the form of the growth lines shown by Dall, Bull. 37 U. S. Nat. Mus., pl. 44, fig. 16, 1889.

Shell like that of the typical section of *Beta* but with a sharper angle and a more evident posterior notch.

Probably nothing is gained by separating this section from *Bela*. It only obscures evident interrelations of the species.

Mangelia (Bela) arteaga Dall and Bartsch

Mangilia arteaga Dall and Bartsch, Canada Dept. Mines, Geol. Surv. Branch., Memoir No. 14-N, p. 11, pl. 2, fig. 4, 1910; Dall, Bull. 112 U. S. Nat. Mus., p. 81, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 84, pl. 13, fig. 4, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 140, 1927.

Shell of moderate size, with medium or high spire; whorls sharply angulated, the shelf above being almost flat or only slightly convex, sloping at a low angle, the side of the whorl below sloping inward, whorls sculptured with about ten sharp axial ribs with wider interspaces, very slightly curving below the angle but showing the trace of the notch above, and with a few sharp, distant spiral lines, the strongest on the angle, making the ribs slightly nodulous; aperture half or a little less than half the length of the shell, elongate-ovate, the posterior end beveled by the angulation, the anterior drawn out into a fairly narrow but poorly defined and rather short anterior canal, outer lip simple, with a distinctly indented, rounded posterior notch above the angle, columella nearly straight, moderately long; animal inoperculate.

Variety **arteaga**, s. s.

Shell with only a moderately high spire, aperture nearly half as long as the whole shell.
Dimensions: Altitude, 10.25 mm.; length of aperture, 4.6 mm.; diameter of body whorl, 4 mm.

Type specimen: In the collection of the Canadian Geological Survey at Ottawa.

Type locality: Barkley Sound, Pacific side of Vancouver Island.

Pleistocene: Lower San Pedro of Nob Hill cut, San Pedro, Los Angeles Co., Calif. (T. S. Oldroyd).
Living: Vancouver Island to San Diego.

Mangelia (Bela) arteaga Dall and Bartsch variety **roperi** Dall

"*Mangilia sculpturata* Dall," Taylor, Nautilus, Vol. 7, p. 101, 1894; Lowe, Nautilus, Vol. 13, p. 29, 1899; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 214, pl. 6, fig. 17, 1903; Berry, Nautilus, Vol. 21, p. 40, 1907; Gripp, Nautilus, Vol. 22, p. 135, 1909.

Mangilia (*Kurtziella*) *arteaga roperi* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 64, pl. 22, fig. 5, 1919.

Mangilia arteaga roperi Dall, Bull. 112 U. S. Nat. Mus., p. 81, 1921; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 140, 1927.

Shell like that of the typical variety, but with a higher spire and shorter aperture.
Dimensions: Altitude, 8 mm.; length of aperture, 3 mm.; diameter of body whorl, 3 mm.

Type specimen: No. 150,993 in the U. S. National Museum.

Type locality: Monterey, California.

Pleistocene: "Pliocene" and lower San Pedro series of Deadman Island, Los Angeles Co., California (Arnold); of San Quintin Bay, Lower California (Jordan).
Living: Monterey, California to Cape San Lucas, Lower California (Dall); ? Vancouver Island (Taylor).

There is little point in separating the variations of this species into varieties, for most of the other Mangelias have a similar long and a short form; but it is interesting to note, if true, that the more southerly individuals of *arteaga* are more often slender than the northern ones. The *Lora sculpturata* Dall, for which this species was mistaken by a number of the earlier conchologists, is a larger, heavier, Alaskan shell with coarser sculpture and an operculum. This species is distinguished from the other species of *Mangelia* by its strong angle and sharp sculpture.

Besides the species of the subgenus *Bela* here considered, the writers are inclined to include also "*Mangilia* (*Kurtziella*)" *cyrene* Dall, 1919, with its probable synonym "*Mangilia* (*Kurtziella*)" *danæ* Dall, 1919, and "*? Mangilia*" *dejanira* Dall, 1919, the last of which would probably fit best in *Bela, s. s.*

Subgenus **MITROMORPHA** Adams in Carpenter, 1865

Mitromorpha A. Adams, Carpenter, Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 182, February or March, 1865; Iredale, Proc. Malac. Soc. London, Vol. 12, p. 328, 1917; Thiele, Archiv für Molluskenkunde, Vol. 56, p. 109, 19—; Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, p. 254 (page in separate 220), 1925.

Not *Mitromorpha* A. Adams, Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 322, April, 1865 = *Antimitra* Iredale (*op. cit.*), which is probably a section of *Mitromorpha* or a subgenus of *Daphnella*, type (by original designation, Iredale) *Pleurotoma ægrota* Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 31, species 276, 1845, + *Daphnella crenulata* Pease, Amer. Journ. Conch., Vol. 3, p. 221, pl. 15, fig. 20, 1868, from Paumotus.

Type (by monotypy), *Mitromorpha filosa* Carpenter.

Shell like that of the typical subgenus but broader, the shape becoming biconic; sculptured with stronger spiral cords, which form, when axial riblets are also present, a reticulate pattern; posterior notch practically obsolete, denticulations sometimes present on the inside of the outer lip, but the lip not thickened.

Geologic range: Upper Pliocene to Recent, California.

Distribution: California, Lower California, Washington, also Alaska, according to Dall, and possibly also the western and southwestern Pacific.

This biconic group of very small Turrids was placed for many years in the *Mitridæ* because of the mitriform appearance of the type species; but none of the species have columellar plications. Carpenter and Tryon classed them in the *Turridæ* with *Daphnella;* and lately Thiele has shown that *M. filosa* has a *Mangelia* radula. The writers have come to the same conclusion as Thiele from a study of the specific relationships, and because these relationships prove to be so close they are inclined to class *Mitromorpha* as a subgenus of *Mangelia*. Thiele thought that Iredale's *Antimitra*, *Lovellona*, and *Apaturris* should have only the value of sections under *Mitromorpha*, but it is possible that the first of these at least might be better classed with *Daphnella*.

The similarity between the species of *Mitromorpha* and the varieties of *Mitrolumna olivoidea* Cantraine, illustrated by Bucquoy, Dautzenberg, and Dollfus (Moll. Mar. Roussillon, Vol. 1, p. 121, pl. 15, figs. 23-39, 1883) is very striking, except that the latter have strong columellar plications and belong to the *Mitridæ*.

Mangelia (Mitromorpha) filosa (Carpenter)

"*? Daphnella*" *filosa* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 658 and note, 1864.

Mitromorpha filosa Carpenter, Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 182, February or March, 1865, reprinted in Smithsonian Misc. Coll., No. 252, pp. 144, 284, (bottom pagination), 1872; Keep, West Coast Shells, p. 55, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, pl. 19, fig. 1, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 223, 1903; Dall, Bull. 112 U. S. Nat. Mus., p. 87, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 173, 1927.

Daphnella (*Mitromorpha*) *filosa* Tryon, Man. Conch., Vol. 6, p. 317, pl. 25, fig. 63, 1884.

Shell small, biconic; whorls convex but overlapping so as to form a smoothly conic spire, sculptured with strong spiral cords only, about 22 on the body whorl, of which three or four show on the spire whorls; aperture more than half as long as the shell, elongate, lenticular, outer lip sculptured on the inside with about twelve small denticles, posterior notch obsolete, columella not defined from the general outline of the body whorl, anterior canal short, blunt, not defined.

Dimensions: Altitude, 8 mm.; length of aperture, 5 mm.; diameter of body whorl, 3.5 mm.

Type specimen: In the British Museum.

Type locality: Santa Barbara, California.

Pleistocene: Lower San Pedro of San Pedro, Los Angeles Co. (Arnold; T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California (Jordan).
Living: Monterey to the Gulf of California (Dall).

This species is an extreme form, but the related species (*gracilior* and *interfossa*) connect it directly with the more typical species of *Mangelia* subgenus *Bela;* and others (*aspera* and *rhyssa*) point to a relationship with *Agathotoma. M. gracilior* is the closest, but it can be distinguished by its retention of the axial riblets on the earlier whorls.

Mangelia (Mitromorpha) gracilior (Hemphill in Tryon)

Plate 25, Figure 22

Daphnella aspera var. *gracilior* Hemphill, Tryon, Man. Conch., Vol. 6, p. 317, pl. 25, fig. 62, 1884.
Mitromorpha intermedia Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 223, pl. 4, fig. 10, 1903.
Mitromorpha filosa intermedia Arnold, Berry, Nautilus, Vol. 22, p. 38, 1908.
Mitromorpha gracilior Hemphill, Dall, Bull. 112 U. S. Nat. Mus., p. 87, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 174, 1927.
Mitromorpha gracilior intermedia Arnold, Dall, Bull. 112 U. S. Nat. Mus., p. 87, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 174, 1927.

Shell small, slender, biconic; whorls somewhat rounded, with impressed sutures, sculptured by rather distant spiral ridges, about twelve on the body whorl of which three or four show on the spire whorls, and by axial riblets which usually become obsolete on the body whorl; aperture elongate, lenticular, less than half the length of the shell, outer lip somewhat arcuate posteriorly, smooth interiorly, columella somewhat elongated, anterior canal not defined.

Dimensions: Altitude, 9.5 mm.; length of aperture, 4.5 mm.; diameter of body whorl, 3.9 mm.

Type specimens: Of *gracilior*, in the Oldroyd Collection at Stanford University; of *intermedia*, No. 162,557 in the U. S. National Museum.

Type localities: Of *gracilior*, living, Monterey, California; of *intermedia*, lower San Pedro Pleistocene, of Deadman Island, San Pedro harbor, Los Angeles Co.

U. Pliocene: Santa Barbara (Arnold; Berry).
Pleistocene: Type locality of *intermedia*.
Living: Forrester Island, Alaska, to San Diego (Dall), no other reference for the northern part of the range.

This species is truly intermediate between *filosa* and *aspera* and *interfossa.* It is more slender than *filosa*, with a more elongate aperture and a smooth outer lip, and has weak axial sculpture. *M. aspera* has stronger axial sculpture forming a nodulous, reticulate pattern with the spirals. *M. interfossa* is similar to *aspera* but has more numerous ribs and spirals than *aspera* and more rounded whorls.

It is interesting to note that Berry identified *intermedia* as living at Monterey.

Mangelia (Mitromorpha) interfossa Carpenter

Mangelia interfossa Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 628, 658, 1864; Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 29, 1865, these publications reprinted in Smithsonian Misc. Coll., No. 252, pp. 114, 144, 242 (bottom pagination), 1872.
Not "*Daphnella interfossa* Carpenter," Tryon, Man. Conch., Vol. 6, p. 310, pl. 22, fig. 57, 1884, = *M. variegata.*

Mitromorpha filosa Carpenter var. *barbarensis* Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 20, pl. 57, fig. 1, 1907, figure reprinted in Bull. 321 U. S. Geol. Survey, pl. 11, fig. 1, 1907.

Mangilia interfossa Carpenter, Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921; Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 85, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 144, 1927.

"*Daphnella fuscoligata* Dall," T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925.

Shell small, biconic; whorls not very much rounded but with distinct sutures, sculptured with about fifteen spiral lines, of which four to six appear on the spire whorls, and with about an equal number of axial riblets that are hardly at all nodulous at the intersections; aperture equal to or a little less than half the length of the shell, elongate, lenticular, outer lip simple, posterior notch obsolete, columella moderately long, anterior canal somewhat drawn out but not distinctly defined.

Dimensions: Altitude, 6 mm.; length of aperture, 3 mm.; diameter of body whorl, 2 mm.

Type specimens: Of *interfossa*, in the British Museum ?; of *barbarensis*, No. 165,245 in the U. S. National Museum.

Type localities: Of *interfossa*, Neah Bay, Washington; of *barbarensis*, upper Pliocene of Bath-house Beach, Santa Barbara.

Pliocene: Type locality of *barbarensis*.

Pleistocene: Lower San Pedro of the Nob Hill cut, San Pedro, Los Angeles Co. (T. S. Oldroyd).

Living: Vancouver Island, British Columbia, to Catalina Island, California (Dall).

The species figured by Tryon is *M. variegata*, which cannot be what Carpenter described as *interfossa* because it has finer, very much more numerous spiral striations and more convex whorls than are called for by Carpenter in his description of *interfossa*. Furthermore, Tryon's figure shows the prominent color band of *variegata*, which Carpenter would surely have mentioned if it had occurred on his specimen of *interfossa*.

M. interfossa is so very close to *M. aspera* that the distinctions must be looked upon as of doubtful value. The two species have not before been recognized as closely related, partly because of Tryon's misidentification and partly because the two have hitherto been classed in different families. *M. interfossa* is distinguished from *aspera* by its somewhat larger size, its more elongate shell, its less convex whorls, and its more numerous, less nodulous axial riblets and spiral cords.

Mangelia (Mitromorpha) aspera (Carpenter)

"*? Daphnella*" *aspera* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 658, 1864; Journ. de Conchyl., Vol. 12 (Ser. 3, Vol. 5), p. 146, 1865; these publications reprinted in Smithsonian Misc. Coll., No. 252, pp. 114, 314 (bottom pagination), 1872.

Daphnella aspera Carpenter, Tryon, Man. Conch., Vol. 6, p. 317, pl. 25, fig. 61, 1884.

Mitromorpha aspera Carpenter, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 208, pl. 19, fig. 3, 1892; Dall, Bull. 112 U. S. Nat. Mus., p. 87, 1921; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 174, 1927.

Shell small, short, biovate; whorls somewhat rounded, sutures shallow, sculpture of about thirteen narrow axial riblets crossed and nodulated by about ten similar spiral cords, of which only two or three show on the spire whorls; aperture a little less than half the length of the shell, lenticular, outer lip simple, not notched behind, columella not differentiated from the outline of the shell, blunt, anterior canal short, not defined.

Dimensions: Altitude, 5.5 mm.; length of aperture, 2.5 mm.; diameter of body whorl, 2.3 mm.

Type specimen: In the British Museum (*fide* Oldroyd).

Type locality: Monterey, California.

U. Pleistocene: San Quintin Bay, Lower California (Jordan).

Living: Monterey to San Pedro (Dall).

This species is intermediate between *interfossa* and *crassaspera*. The former has finer sculpture and a more drawn-out anterior canal; the latter has coarser sculpture and an aperture expanding anteriorly, with practically no canal. The latter has not generally been recognized as related because the species of this group have lately been so widely scattered among other genera.

Mangelia (Mitromorpha) crassaspera, new name

Daphnella fuscoligata Dall, Amer. Journ. Conch., Vol. 7, p. 100, 1871; Tryon, Man. Conch., Vol. 6, p. 301, pl. 34, fig. 95, 1884; Dall, Bull. 112 U. S. Nat. Mus., p. 83, 1921; not of T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 150, 1927; not *Mangelia ? rigida*, var. *fuscoligata* Carpenter, Proc. Zool. Soc. London, p. 163, 1856.

Shell of medium size, spire moderately high; whorls somewhat rounded, sutures shallow, sculpture of strong axial riblets, about twelve to a whorl, crossed by equally strong spiral cords, six or seven on the body whorl, two of which show on the spire whorls, riblets nodulous at the intersections; aperture less than half as long as the shell, ovate, wider anteriorly, outer lip moderately curving, with a faint posterior notch close to the suture, columella hardly differentiated from the general outline of the body whorl, not long, anterior canal short, shallow.

Dimensions: Altitude, 8 mm.; length of aperture, 3.5 mm.; diameter of body whorl, 3.2 mm.

Type specimen: In the U. S. National Museum.

Type locality: Monterey, California.

Living: Monterey to San Diego (Dall).

It was hoped that this species would fall as a synonym of *aspera* so that the nomenclatorial difficulties of handling it in a subgenus of *Mangelia* could be avoided; but the specimens in the Oldroyd Collection at Stanford University are not conspecific, unless the variability is greater than the specimens mentioned give evidence of. It is to be noted, however, that they come from the same type locality and have nearly the same distribution.

M. crassaspera is distinguished from *aspera* by its somewhat larger size (with the same number of whorls), by its coarser sculpture, and by its differently shaped aperture. "*Mangilia*" *muricidea* Moody is quite similar in general appearance, but it has a longer columella and anterior canal, and it is probably the same as "*Turris*" *kirkensis* Clark, which is the young of *Tritonalia lurida* variety *munda* (Carpenter). *M. crassaspera* is closely related to *M. rhyssa* Dall, which is smaller and has a higher spire and shorter aperture. *M.* (*Bela*) *interlirata* Stearns is also very similar; but it is high spired and larger, and the ribs are higher than the spirals, as in typical *Mangelia*. There are really no gaps in these series of species suitable for drawing subgeneric divisions; but some of the extremes are distinct enough to warrant the few subgeneric groups here outlined.

M. crassaspera bears a striking resemblance to *Mangelia quadrillum* (Dujardin) from the Miocene of France (figured by Cossmann, Ess. Paléo. Comp., Vol. 2, pl. 7, fig. 14, 1896).

Mangelia (Mitromorpha) rhyssa Dall

Mangilia (Clathromangilia) rhyssa Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 62, pl. 21, fig. 3, 1919.

Mangilia rhyssa Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 143, 1927.

? Clathromangilia rhyssa Dall, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925.

Shell similar in sculpture to *M. crassaspera*, but with a taller, narrower spire and a short, narrow aperture, posteriorly rounded and anteriorly without a canal.

Dimensions: Altitude, 7 mm.; length of aperture, 2.5 mm.; diameter of body whorl, 2.5 mm.

Type specimen: No. 55,479 in the U. S. National Museum.

Type locality: Gulf of California (I. S. Oldroyd gives San Diego, but Dall names only the Gulf of California, Stearns Collection, in the original).

Pleistocene: Lower San Pedro of Nob Hill cut, San Pedro, Los Angeles Co. (T. S. Oldroyd).
Living: San Diego to the Gulf of California.

This peculiar little species looks more like the type of *Clathromangelia*, which is probably a synonym of *Clathurella*, than a *Mitromorpha;* but its specific relationships seem to be with the latter, and it lacks the deep notch and the thickened, denticulate outer lip of the former. *Clathurella* is more distantly related through *Agathatoma.*

Besides the species here considered, the writers are inclined to class "*Clathrodrillia*" *limans* Dall, 1919, also in the subgenus *Mitromorpha*, although it is possible that this peculiar little species may belong to *Anachis*, subgenus *Chauvetia*, in the *Pyrenidæ.*

Subgenus **ZETEKIA** Dall, 1918

Zetekia Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 320, 1918.

Type (by monotypy), *Zetekia denticulata* Dall, briefly diagnosed, 1918, described and figured, Proc. U. S. Nat. Mus., Vol. 56, p. 73, pl. 1, fig. 1, 1919, living, Panama.

Shell short and conical like that of *Mitromorpha*, with axial and spiral cords meeting in little beaded knobs; both lips denticulate, anterior canal short, undefined, somewhat notched, otherwise as in *Agathotoma.*

Distribution: Panama.

This subgenus is intermediate between *Mitromorpha* and *Agathatoma.* Perhaps "*Philbertia*" *telamon* Dall, 1919, from the Gulf of California, should be classed here.

Subgenus **AGATHOTOMA** Cossmann, 1889

Ditoma Bellardi, Mem. R. Accad. Sci., Torino, Ser. 2, Vol. 29, p. 295, 1877; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 125, 1896.

Agathotoma Cossmann, Revue Critique de Paléozool., Vol. 3, p. 1, 1899, new name for *Ditoma* Bellardi, 1875, *non* Illiger, 1807; Ess. Paléo. Comp., Vol. 3, p. 192, 1899.

"*Cytharella* Monterosato," Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 320, 325, 1918, type *Pleurotoma bertrandi* Payraudeau, not in Monterosato's original list; so used by Dall and other authors after 1918.

"*Philbertia* Monterosato," Dall, in part.

Type (by monotypy), *Mangelia angusta* Jan, Miocene and Pliocene of Europe, described by Bellardi (*loc. cit.*), figured by Cossmann, Ess. Paléo. Comp., Vol. 2, pl. 7, figs. 29, 30, 1896.

Shell like that of the typical subgenus but with a deeper posterior notch at all stages of growth, and often a somewhat thickened outer lip, the columella and anterior canal comparatively short and blunt; sculpture of wave-like axial folds crossed by spiral grooves.

Geologic range: Eocene to Recent (Cossmann, as *Mangelia*).

Distribution: Tropical, subtropical, and occasionally temperate waters of all seas.

This subgenus appears quite different from the typical *Mangelia*, especially in illustrations; but an examination of specimens shows that the differences in aspect are due to a very slight variation in characters. The shells are for the most part thin except at the varices, which, as in the typical subgenus, serve to strengthen the shell, and when small in number meet end to end to form continuous ridges up the spire. The ridges are stronger and more wave-like than in the typical subgenus and are crossed by fewer, stronger spiral grooves. The principal differences are in the depth of the notch and the length of the anterior canal; but these differences are a matter of degree only and all intergradations occur. *Bela* is more distinct than typical *Mangelia*, having a weaker notch and smaller axial ribs; but intergradations even between *Bela* and *Agathotoma* occur, and such species as *interlirata* Stearns might be placed in the section *Mangiliella*, intermediate between the two subgenera. The subgenus *Pseudoraphitoma* is similar to *Agathotoma*, but has a higher spire, a shorter aperture, and a denticulate outer lip.

The species of this subgenus vary considerably in form: those with thinner shells and less thickened outer lip approach *M. merita* of the typical subgenus; those with higher spires, few longitudinal ridges continuous up the spire crossed by fine spiral grooves approach *Pseudoraphitoma;* those with coarser spirals resemble somewhat *Clathurella*, but do not have the same kind of posterior notch, nor are they apt to have denticles on the inside of the outer lip as in *Clathurella*. The typical species of *Agathotoma* are those that approach *Pseudoraphitoma*. They have a strongly thickened outer lip, into which the posterior notch is deeply sunken, part of the lip often forming a swollen collar around the notch and joining onto the upper part of the otherwise not thickened inner lip. Also, there may be a single, more or less prominent fold or denticle on the inside of the outer lip immediately below the notch. These features are shown in the rib-stage of typical *Mangelia*, though less strongly.

So far no true species of *Agathotoma* have been reported as fossil in California or Lower California, but there are a number of living species that might be expected to appear in the fossil state at any time. Among these the writers would include the following:

"*Cytharella*" *niobe* Dall, 1919.
"*Philbertia*" *hilaira* Dall, 1919.
"*Philbertia*" *scammoni* Dall, 1919.
"*Philbertia*" *doris* Dall, 1919.
"*Cytharella*" *phæthusa* Dall, 1919.
"*Cytharella*" *louisa* Dall, 1919.
"*Cytharella*" *subdiaphana* (Carpenter), Dall, 1919.
"*Cytharella*" *quadriseriata* Dall, 1919.
"*Cytharella*" *hippolita* Dall, 1919.
"*Cytharella*" *aculea* Dall, 1919.
"*? Hædropleura*" *melita* Dall, 1919.
"*Philbertia*" *helena* Dall, 1919.
"*Philbertia*" *telamon* Dall, 1919.
"*Philbertia*" *dictynna* Dall, 1919.
"*Philbertia*" *ægialea* Dall, 1919.
"*Philbertia*" *æthra* Dall, 1919.
"*Cytharella*" (*Agathotoma*) *penelope* Dall, 1919.
"*Cytharella*" (*Agathotoma*) *camerina* Dall, 1919.
"*Cytharella*" (*Agathotoma*) *euryclea* Dall, 1919.
"*Cytharella*" (*Agathotoma*) *pyrrhula* Dall, 1919.
"*Cytharella*" (*Agathotoma*) *phryne* Dall, 1919.
"*Cythara*" *victoriana* Dall, 1897, (figure reproduced by Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 86, pl. 45, fig. 14, 1924).

These species are arranged roughly in the order of similarity. There are probably many synonyms among them, for Dall took practically no account of variation, and many of the older names of Hinds, Reeve, Carpenter, Adams, and others are yet to be considered.

Subgenus **PSEUDORAPHITOMA** Boettger, 1895

Pseudoraphitoma Boettger, Deutsche Malakozoologische Gesellschaft (Frankfurt-am-Main), Nachrichtsblatt, p. 56, 1895.

Type (by monotypy), *Mangilia fairbanki* Nevill, living, Bombay, figured by Tryon, Man. Conch., Vol. 6, p. 270, pl. 22, fig. 48, 1884.

Shell like that of *Agathotoma* but with a high spire and denticles on the inside of the outer lip.

This subgenus has not yet been recognized along the Pacific coast of North America; but several species of *Agathotoma*, such as *hippolita*, etc., approach it.

Genus CYTHARA Schumacher, 1817

Cythara Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 245, 1817; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 319, 325, 1918.

Mangelia Leach, Reeve, Conch. Icon., Vol. 3, 8 pls., 1846, not *Mangelia* Risso, 1826.

Eucithara Fischer, Man. Conchyl., p. 593, 1883, new genus proposed with *Cythara* Schumacher, 1817, *non* Klein, 1753, in synonymy and *M. stromboides* Reeve cited as an example; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 120, 1896, type cited *Cancellaria citharella* Lamarck; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 326, 1918; Hedley, Rec. Australian Mus., Vol. 13, p. 260, 1922; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 168, 1928.

Type (by monotypy), *Cythara striata* Schumacher, *loc. cit.*, 1817, based on Chemnitz, Neues Syst. Conch. Cab., Vol. 4, p. 166, pl. 142, fig. 1330 only, 1780, = *Pterygia subterranea* Bolten, Mus. Bolt., p. 51, 1798, + *Cancellaria citharella* Lamarck, Hist. Nat. Anim. s. Vert., Vol. 7, p. 115, 1822; Desh. and M. Edw. Ed., Vol. 9, p. 407, 1843; discussed and illustrated by Reeve, Conch. Icon., Vol. 3, *Mangelia*, introduction to the genus, and pl. 1, species 5, 1846; figure repeated by Tryon, Man. Conch., Vol. 6, p. 257, pl. 24, fig. 13, 1884.

Shell of medium size, spire usually rather low; whorls angulated near the top, sculptured with a moderate number of long, curving, rounded axial ribs, crossed by much less prominent spiral striations or color bands; aperture very long and narrow, averaging about three-fifths as long as the shell, usually in mature shells bordered on both sides with a row of denticles, outer lip sometimes flaring posteriorly and bent inward just below the flare as in *Pyrene*, inner lip, columella, and outline of the body whorl passing downward nearly straight, like an inverted elongate cone, anterior canal a somewhat irregular prolongation of the aperture, notched behind.

Distribution: Southwestern Pacific and Indian Ocean.

This genus offers several very perplexing nomenclatorial problems besides the zoological problem of determining the identity of the type species. Recently Hedley and Woodring have decided to abandon the name entirely; but the writers feel that this course is not necessary, and that if it were, the name *Eucithara*, used by Hedley and Woodring, is not available as a substitute.

The aim of the International Code of Zoological Nomenclature is to stabilize the use of names by making as few changes as possible. Therefore, when a name is entitled to priority and has been in current use for some time, *the burden of the proof* lies upon those who wish to change the name; and before they have a right to change it or before they should be followed in doing so, they must offer proof that the old name has been improperly applied. It does not seem sufficient to the writers for them to show that it *might* have been improperly applied.

Thus the name *Cythara*, which is the oldest name that has been applied to this group of species, has been in use for many years by workers in all parts of the world. The genus was based on a description by Schumacher and a figure in Chemnitz, neither of which is incompatible with the generally accepted usage, though it must be admitted that neither is very satisfactory. The fact that Chemnitz figured his specimen along with young *Strombi* is not of importance, for Schumacher specifically denies any relation with the other figures. Reeve carefully explains Lamarck's error in referring the species to *Cancellaria*. The reference of the species by older writers to various other genera casts doubt upon its identity, but does not prove anything in the face of Reeve's deliberate and fully explained identification of the species as a member of the group we are now considering. Furthermore, even if Reeve should have mistaken the species (the species illustrated by Reeve lacks the apertural denticulations specified by Schumacher and may be immature), if the species can be identified merely as an unknown or not yet determined member of the group, it is sufficient to establish the use of the name. Thus, the present writers have come to the conclusion that sufficient proof has not yet been presented to overthrow the accepted usage of *Cythara*, which of course is not preoccupied by the pre-Linnæan *Cithara* Klein.

If later the specimens of Chemnitz are found and consulted, all doubt can then be removed about the proper application of the name. If it should be discovered that the species belongs to some other genus, it will be time enough then to propose a substitute, whereas if the general usage of the term has been correct, a double shifting of names will have been avoided.

The availability of the name *Eucithara* Fischer as a substitute is seriously open to question. Many nomenclature specialists would say that as *Eucithara* was proposed as a substitute for *Cythara* on the mistaken contention that the name was preoccupied, the name must be an exact synonym, having for its type the same species as *Cythara*. However, the present writers believe that both the species originally cited by the author of the original genus (the genus that was listed in the synonymy of the new genus) and the species given by the author of the new genus at the time the name was proposed should be available for type, and that the type should be determined according to the ordinary processes of type fixing. Fischer named no type, and as there is no tautonymy, the type must be fixed by subsequent designation. Cossmann, 1896, is the first to designate a type, naming *Cancellaria citharella* Lamarck. It might be contended that this species was not present by name in either list and that therefore the designation is invalid; and it is true that the citing of even a generally accepted synonym of a species cannot be accepted as a valid designation, if the synonymy is a matter of opinion, for there would be danger that at some time the two names might be shown to apply to different species. In this particular case, however, the two names are in a technical sense exact synonyms, being based on the same figure and therefore having the same type specimen, so there never could be any doubt about the species *citharella* being present in Schumacher's original list. The writers believe, therefore, that in such cases of exact synonyms it would be an absurd technicality to declare the citation invalid; and they conclude that although Fischer's example was originally available for type, it was no longer so after Cossmann's designation in 1896. Thus, *Eucithara* is to be regarded as an exact synonym of *Cythara*.

Cythara is distinguished from the other small Turrids by its short spire, its elongately conical body whorl, and its long, narrow aperture with denticulate margins. *Conopleura* Hinds[1] is merely an extreme form of the same genus with sharper shoulders and a somewhat deeper posterior notch, recalling *Pleurotomoides*. *Cytharopsis* A. Adams[2] may be an elongate form of this genus with stronger spiral sculpture. If the name *Cythara* is unacceptable to nomenclature specialists, these two names should be considered before another substitute is proposed. The genus *Cythara* has been discussed here, although it appears to be entirely foreign to North America, partly because it was hoped that such a discussion might help to clarify some of the current nomenclatorial problems, and partly because it was considered important to show what has become of one of the oldest names that has been applied to California Turrids. The reference by Gabb, Dall, Pilsbry,[3] and others of several species in the Tertiary of Florida and the West Indies to this genus is somewhat questionable, but it is still not unlikely that the genus might be found, along with other Oriental genera, in the older Tertiary of California.

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[1] *Conopleura* Hinds, Zool. Voy. *Sulphur*, Moll., p. 24, 1844, type (by monotypy) *C. striata* Hinds described, *loc. cit.*, and figured pl. 7, figs. 22, 23, not *striata* Schumacher; = *Pleurotoma partita* Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 36, species 330, 1846, figures reproduced by Tryon, Man. Conch., Vol. 6, p. 211, pl. 8, figs. 6, 7, 1884.

[2] *Cytharopsis* A. Adams, Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 323, 1865, type (by monotypy ?) *Mangelia* (*Cytharopsis*) *cancellata* A. Adams, described *loc. cit.*, but not figured; described by Tryon, Man. Conch., Vol. 6, p. 274, 1884.

[3] Pilsbry, Proc. Acad. Nat. Sci., Phila., Vol. 73, pp. 322-23, 1922.

Genus CLATHURELLA Carpenter, 1857

Clathurella Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 399, 1857, new genus proposed with *Defrancia* Millet not Bronn in the synonymy and with *Clavatula rava* Hinds and *Clathurella aurea*, new species, as examples for "A convenient group of the *Mangelia* tribe; the name *Defrancia*, previously in use, being preoccupied;" Cossmann, Ess. Paléo. Comp., Vol. 2, p. 121, 1896, type cited *Clavatula rava* Hinds.

Glyphostoma Gabb, Proc. Acad. Nat. Sci., Phila., p. 270, 1873, type (by monotypy) *Glyphostoma dentiferum* Gabb, described, *loc. cit.*, and illustrated, pl. 9, fig. 4, also described and figured by Cossmann in the Ess. Paléo. Comp., Vol. 2, p. 124, text figure 29, 1896, and in the Journ. de Conchyl., Vol. 11, p. 31, pl. 2, figs. 15-17, with variety *martinicensis* Cossmann, figs. 18-20, 1913, and by Pilsbry, Proc. Acad. Nat. Sci., Phila., Vol. 73, p. 324, pl. 17, fig. 15, 1922, Miocene, West Indies; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 191, 1928.

? *Clathromangelia* Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 131, 1884, type (by monotypy) *Pleurotoma granum* Philippi, Enum. Moll. Siciliæ, Vol. 2, p. 170, 1844, + *P. rude* Philippi, Vol. 1, p. 199, pl. 11, fig. 16, 1836, (not *P. rude* Broderip), figure reproduced by Tryon, Man. Conch., Vol. 6, p. 276, pl. 33, fig. 68, 1884, Recent, Mediterranean.

Lienardia Jousseaume, Bull. Soc. Zool. France, Vol. 8, p. xl, 1884, Vol. 9, p. 184, 1884, type (by original designation) *Clavatula rubida* Hinds, Proc. Zool. Soc. London, p. 40, 1834, Zool. Voy. *Sulphur*, Moll., p. 18, pl. 6, fig. 6, 1844, also illustrated by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 25, species 220, 1845, and by Tryon, Man. Conch., Vol. 6, p. 271, pl. 15, fig. 34 (coloring not typical), pl. 19, fig. 51, 1884, Recent, New Guinea; Hedley, Rec. Australian Mus., Vol. 13, p. 285, 1922.

Hemipleurotoma Boettger, Deutsche Malakozoologische Gesellschaft (Frankfurt-am-Main), Nachrichtsblatt, Jahr. 27, p. 52, 1895, type (by original designation) *Pleurotoma* (*Defrancia*) *malleti* Recluz, Journal de Conchyl., Vol. 3, p. 254, pl. 10, fig. 2, 1852, also figured by Tryon, Man. Conch., Vol. 6, p. 297, pl. 20, figs. 96, 100, 1884, Recent, western Pacific; Hedley, Rec. Australian Mus., Vol. 13, p. 294, 1922.

Not *Clathurella* Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 259, 1908; etc.

Type (by subsequent designation, Cossmann, 1896), *Clavatula rava* Hinds, Zool. Voy. *Sulphur*, Moll., p. 17, pl. 5, fig. 18, 1844, also illustrated by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 28, species 250, 1845, and by Tryon, Man. Conch., Vol. 6, p. 296, pl. 18, fig. 42, 1884, Recent, Philippines.

Shell of medium or small size; protoconch consisting of two or three small bulbous whorls, smooth except for an obtuse angle which appears on the second whorl of species that have markedly angulated whorls; adult whorls usually angulated near the top, in which case the area of the anal fasciole above is concave, sculptured only with strongly curving growth lines or fine spiral lines or both, sculpture on the main part of the whorl of broad rounding ribs crossed by spiral cords of varying strength; aperture varying from two to three-fifths the length of the shell, elongate-ovate, prolonged at both ends by similar, deep, notched canals, outer lip of adult shell thickened and provided with a number of rather prominent denticles, posterior notch heavily armored on both sides, inner lip also usually denticulate, with a callus reinforcement at the top, columella rather long, nearly straight, anterior canal short but usually well defined, notched and flaring at the end; animal inoperculate.

Geologic range: Eocene (of Australia, *fide* Cossmann), lower Miocene to Recent in the West Indian region (Woodring); Pliocene to Recent, California.

Distribution: Tropical and warm temperate waters of all oceans.

Here again we have the nomenclatorial question of whether a species included in a genus by the original author of the genus at the time and place in which he proposed the generic name can be available for type, even though the synonymy of the new generic name may include an older, preoccupied name, in the original description of which that species was not included. The present writers think it can, and therefore accept Cossmann's designation of the type of this genus. They have discussed this nomenclatorial point under the genera *Lora*, *Raphitoma*, and *Cythara*.

A number of writers recently have been inclined to recognize most of the names here listed in the synonymy as distinct genera along with a number more of their own proposing. Time has not allowed a thorough investigation of the later names, but the present writers are convinced that most of them are based on unessential differences and that the nomenclatorial extravagance tends to obscure the natural facts without increasing the accuracy of the classification. For instance, *Lienardia* is nearly always separated from *Glyphostoma*, and yet Woodring in figuring species of *Glyphostoma* from the Miocene of the West Indies in the district where Gabb found the type of *Glyphostoma* figures one, *G. guppyi*, which is barely distinguishable specifically from the type of *Lienardia*. Not only that, but there are typical species of *Glyphostoma* with broad fascioles even in the western Pacific. Usually the protoconchs are relied upon as a last resort to separate these supposed genera on the theory that diverse protoconchs indicate different ancestry. However, as explained in the introduction to the *Turridæ*, too little is yet known about the significance of protoconchs to make them reliable as criteria for distinguishing genera.

Two interesting observations were made on the protoconchs of this genus. One was that among the species that had strongly angulated adult whorls the angulation of the protoconch whorls was most conspicuous, as if the latter were due entirely to an acceleration of the time in the development of the individual at which the angulated character first appears. The other was that the blunt appearance of the protoconchs of the western Pacific species is usually due to wear. Of seven specimens of *C. rubida* (Hinds) in the Oldroyd Collection at Stanford University, only one small one had a sharp apex as in Reeve's figure. On all the others the protoconchs, and in some cases one of the mature whorls as well, were smoothly ground down to a blunt point as if they had always been that way. Hedley mentions that the protoconch of *Etrema*, one of his new names for this genus, is essentially the same as that of *Glyphostoma*.

Clathurella varies considerably in size, in the relative height of the spire, the relative strength of the spiral and axial sculpture, the width of the anal fasciole, the sharpness of the angulation of the whorls, and the amount of armature of the lips and of the posterior notch. It grades into the coarsely sculptured species of *Mangelia* and into *Raphitoma*, but it can usually be distinguished by its deep, heavily armored posterior notch, its denticulate lips, its concave anal fasciole, and its short, distinctly defined anterior canal. Young specimens do not have the denticulated lips, and some species may never develop them, but usually such species can be recognized by the other characters. This genus probably grades in the other direction into *Cythara*, but the latter can usually be distinguished by its lower spire, etc. It also approaches very closely small species of *Clavus* of the subgenera *Clathrodrillia*, *Cymatosyrinx*, *Crassispira*, etc.; but the latter do not have denticulate lips, do have opercula, and are normally considerably larger.

A large number of species of this genus that have been described from southern waters by Hinds, Reeve, Adams, Carpenter, and others the writers have not had time to look up. Probably most of Dall's recently named species will fall into the synonymy of the older names. The following notes do not include all of the living species:

Clathurella candida (Hinds)

Clavatula candida Hinds, Proc. Zool. Soc. London, p. 42, 1843; Zool. Voy. *Sulphur*, Moll., p. 20, pl. 6, fig. 18, 1844.

Pleurotoma candida Hinds, Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 25, species 221, 1845.

Mangilia candida Hinds, Tryon, Man. Conch., Vol. 6, p. 273, pl. 15, fig. 41, 1884.

Glyphostoma partefilosa Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 53, pl. 17, fig. 4, 1919.

Shell broad, with rounded ribs, striations only on the columella; aperture and notch heavily armored.

Living: Gulf of California to the Magnetic Island, west coast of Veragua.

Dall, as is so often the case, makes no comparisons, and yet the synonymy is quite evident.

Clathurella conradiana Gabb

Plate 26, Figure 11

Clathurella conradiana Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 7, pl. 1, fig. 12, 1866, p. 73, 1868-9; Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 297, 1874; Cooper, 7th Ann. Rept. Calif. St. Mining Bureau, p. 235, 1888; Arnold, Bull. 321 U. S. Geol. Survey, p. 32, pl. 11, fig. 9, 1907.

Mangilia (*Clathurella*) *conradiana* Gabb, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 210, 1903; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, 1916.

Glyphostoma cymodoce Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 54, pl. 17, fig. 6, 1919; Bull. 112 U. S. Nat. Mus., p. 79, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 127, 1927.

Glyphostoma conradiana Gabb, Dall, Bull. 112 U. S. Nat. Mus., p. 79, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 126, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Shell of moderate size, with a fairly high spire; whorls angulated near the top, concave above where they are sculptured with six or seven fine spiral lines and strongly curving growth lines, convex below and sculptured with 10 to 12 rounded axial ribs crossed by spiral cords, about 14 of the latter on the body whorl, three or four showing on the spire whorls, with sometimes a few lesser intercalaries; aperture about two-fifths the length of the shell, ovate, prolonged at both ends by very similar canals, outer lip of the adult somewhat thickened, denticulate within, posterior notch deep, inner lip incrusted, only moderately armed at the top, columella fairly long, straight, anterior canal defined, short, notched behind.

Dimensions: Altitude, 11 mm.; length of aperture, 5 mm.; diameter of body whorl, 4 mm.

Type specimens: Of *conradiana*, at the University of California; of *cymodoce*, No. 150,569 in the U. S. National Museum.

Type localities: Of *conradiana*, "Post-Pliocene of Santa Barbara;" of *cymodoce*, living, Santa Barbara.

M. Pliocene: San Diego well (Dall, 1874).

U. Pliocene: Santa Barbara (Gabb; Arnold); Fourth and Broadway, Los Angeles (Moody); upper Pico of Ventura Co. (Waterfall); loc. 218 S. D. S. N. H., Sulphur Canyon east of South Mountain, Ventura Co., one specimen (H. R. G.).

Pleistocene: "Pliocene" and lower San Pedro series at Deadman Island, San Pedro harbor, and San Pedro, Los Angeles Co. (Arnold).

Living: Monterey to San Pedro, and possibly south to Ecuador.

A certain amount of variability is to be expected in this species as in others, but the writers have not had sufficient material to determine its extent. The synonymy seems quite plain in the case of *cymodoce*, and the synonymy of other described forms seems quite probable. *Glyphostoma adana* Dall, 1919, from Lower California, and *G. sirena* Dall, 1919, from the Galapagos, are very close to *conradiana;* and "*Mangilia*" *laodice* Dall, 1919, is probably an immature *Clathurella*, perhaps also belonging to this species. *G. adria* Dall, 1919, from Lower California, has a more heavily armed lip, though the notch does not protrude sideways as much as that of *C. rava* (Hinds). *C. affinis* Dall[1] is a form ranging from San Miguel Island, California, to San Martin Island, Lower California, perhaps a variety of this species with stronger, more rounded axial ribs. The specimen here figured has something of this character, and there is one specimen of this form in the Oldroyd Collection at Stanford University labeled *Clathurella canfieldi;* but the specimens labeled *Clathurella affinis* are all *canfieldi*. *C. canfieldi* has shorter, broader whorls and typically weaker sculpture, but many specimens have stronger sculpture than the type and some have been identified as *conradiana* by Arnold, T. S. Oldroyd, and others. *C. canfieldi* may also be a variety of *conradiana*. *C. thalassoma* (Dall),[1] from the Gulf of California, is a large species with more uniform, clathrate sculpture recalling somewhat *C. dentifera* (Gabb) not (Hinds), = *? martinicensis* Cossmann, from the Atlantic Miocene, and is probably a distinct species. Dall's "*Mangilia*" *philodice*, said to range from Point Año Nuevo, middle California, to the Coronado Islands off San Diego, looks very much like the young of *thalassoma* with the nucleus eroded.

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[1] *Clathurella affinis* Dall, Amer. Journ. Conch., Vol. 7, p. 102, 1871; Proc. Calif. Acad. Sci., Vol. 5, p. 62, pl. 2, fig. 7, 1873; Baker, Nautilus, Vol. 16, p. 41, 1902.

Philbertia affinis Dall, Bull. 112 U. S. Nat. Mus., p. 79, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 128, 1927.

Clathurella canfieldi Dall

Clathurella canfieldi Dall, Amer. Journ. Conch., Vol. 7, p. 101, pl. 15, fig. 9, 1871.
Philbertia canfieldi Dall, Bull. 112 U. S. Nat. Mus., p. 79, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10 in part ?, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 128, 1927.
? "Glyphostoma conradiana Gabb," T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 10, 1925.

Shell much like that of *conradiana*, but with a shorter spire, the angulation higher on the whorls with only a narrow shelf above and the sides of the whorls almost vertical below, sculpture typically weaker and smoother, but grading into forms very much as in *conradiana;* aperture broader, but with similar small denticles on the outer lip, present only on fully mature specimens or at certain growth stages, and a similar, weakly armored notch.

Dimensions: Altitude, 8 mm.; length of aperture, 4.2 mm.; diameter of body whorl, 3.5 mm.

Type specimen: In the U. S. National Museum.

Type locality: Living, Monterey.

Pleistocene: Lower San Pedro of San Pedro and vicinity, Los Angeles Co. (T. S. Oldroyd; Arnold; etc.).
Living: Crescent City, northern California, to Laguna Beach, a short distance south of Los Angeles.

This species, although typically quite different, seems to intergrade with *conradiana*, and better material may show that the differences are of no more than varietal significance. As is nearly always the case when fine distinctions between species are described indefinitely or not described at all, each form has been identified by one or two authors (in this instance probably including Dall himself) under the name of the other; and instead of producing accuracy the fine distinction merely produces complexity.

There is an older name that has been overlooked for many years, but which may, when the type is illustrated and more fully described, turn out to be the proper name for this species,—*Mangelia hamata* Carpenter.[2] Dall states that the type of Carpenter's species looks like a fossil and may have come from the "Pleistocene" of Santa Barbara where Col. Jewett also collected, instead of from Panama where Carpenter reports that Jewett collected it. The rather deep anal sulcus and thickened lip, with the dimensions given by Carpenter, suggest that the species may belong here. Nevertheless, without an illustration it is impossible to be sure that it is not allied to *Mangelia merita* or some other group. It is regrettable that Dall did not figure the type (No. 15,951 in the U. S. National Museum) when he had it before him.

Clathurella crystallina Gabb

Clathurella crystallina Gabb, Proc. Calif. Acad. Sci., Vol. 3, p. 184, 1865.
Clathurella lowei Dall, Proc. Biol. Soc. Wash., Vol. 16, p. 172, 1903 (*fide* Dall).
Philbertia crystallina Gabb, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 62, pl. 13, fig. 1, 1919; Bull. 112, U. S. Nat. Mus., p. 79, pl. 6, fig. 4, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 129, pl. 3, fig. 5, 1927.

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[1] *Glyphostoma thalassoma* Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 280, 1908; Proc. U. S. Nat. Mus., Vol. 56, p. 52, pl. 17, fig. 2, 1919.

? Mangilia philodice Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 66, pl. 22, fig. 7, 1919; Bull. 112 U. S. Nat. Mus., p. 81, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 139, 1927.

[2] *Mangelia hamata* Carpenter, Ann. and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 399, May, 1865, reprinted in Smithsonian Misc. Coll., No. 252, p. 293 (bottom pagination), 1872.

Mangilia hamata Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 71, 1919.

Shell somewhat like the last but with a broader, more sloping area above the angle and a few sharper, more prominent spiral keels on and below the angle.

Type specimens: Of *crystallina*, at the University of California (?); of *lowei*, No. 109,305 in the U. S. National Museum.

Type locality: Of both, 40 fathoms off Catalina Island. Known only from the type locality.

This species was called *Philbertia* by Dall because the specimens so far found have not had denticles on the outer lip; but it is quite clearly a *Clathurella*, perhaps immature.

Clathurella trichodes (Dall)

Pleurotoma hirsutum de Folin, Les Méléagrinicoles, p. 59, pl. 5, fig. 16, 1867, not *Pleurotoma hirsuta* Bellardi, 1848.

Philbertia trichodes Dall, new name for *Pleurotoma hirsutum* de Folin, Proc. U. S. Nat. Mus., Vol. 56, p. 62, pl. 19, fig. 3, 1919.

Shell very small; whorls five, of which the first is smooth, others sculptured with a few strong, distant cords both axially and spirally, though sometimes the shell thin and nearly smooth; aperture about half the length of the shell, with a very deep posterior notch, outer lip with a few coarse denticles, columella nearly straight, not encrusted at the top, anterior canal short, deep.

Dimensions: Altitude, 4 mm.; length of aperture, 1.9 mm.; diameter of body whorl, 2 mm.

Type locality: Panama Bay (*fide* Dall).

Distribution: Panama to the Gulf of California (Oldroyd Collection at Stanford University).

This interesting little species is included to call attention to the change of name and to record its presence in the Gulf of California. It may be related to *Nannodiella*.

Subgenus **NANNODIELLA** Dall, 1919

Nannodiella Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 329, type (by monotypy) *N. nana* Dall, nude name, 1918; Vol. 56, p. 59, 1919; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 194, 1928.

Type (by original designation), *Philbertia* (*Nannodiella*) *nana* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 59, pl. 20, fig. 7, 1919.

Shell like that of *Clathurella* but much smaller, the posterior notch armored and projecting like a spout, but the lips not denticulate.

Geologic range: Miocene to Recent, West Indies (Woodring).

Distribution: Lower California and the Gulf of California; West Indies and Florida.

Nannodiella is a dwarf group of *Clathurella*, being like the young of typical *Clathurella*, but with a mature notch.

Genus RAPHITOMA Bellardi, 1848

Defrancia Millet, Mém. de la Soc. Linn. de Paris, p. 437, 1826-1827, in part, not the type; not *Defrancia* Bronn, 1825, genus of Bryozoa.

Pleurotomoides Bronn, Ital. Tert.-Geb., p. 47, 1831, in part, not the type cited by Dall, 1918 (see heading for *Pleurotomoides*); Dautzenberg and Fischer, Travaux de la Station Biologique de Roscoff, Fascicule 3, p. 32, 1925, type cited *Murex reticulatus* Renier.

Raphitoma Bellardi, Accad. delle Scienze di Torino, Memorie, Ser. 2, Vol. 9, p. 613, 1848, first species *Pleurotoma histrix* Jan followed by many others; Monterosato, Bolletino della Società Malacologica Italiana (Pisa), Vol. 1, p. 73, 1875, type cited *Pleurotoma histrix* Jan; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 179, 1928.

Clathurella Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 399, 1857, in part, not the type cited by Cossmann, 1896 (see heading for *Clathurella*); Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 259, 1908.

Homotoma Bellardi, Bolletino della Società Malacologica Italiana (Pisa), Vol. 1, p. 22, 1875, species included in the original list, *Homotoma reticulata* (Renier) and *Homotoma semicostata* Bellardi; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 188, 1928, no type has been selected from these two species; not *Homotoma* Guerin-Méneville, 1829.

Bellardia Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 88, 1883, type (by monotypy) *Murex gracilis* Montagu, living Great Britain, described and figured in nearly all the important works dealing with *Turridæ;* not *Bellardia* Mayer, 1870, nor Robineau-Desvoidy, 1863.

Bellardiella Fischer, Man. Conchyl., p. 594, December, 1883, new name for *Bellardia* Bucquoy, Dautzenberg, and Dollfus, not Mayer, 1870; not *Bellardiella* Tapp. Canefri, July, 1883.

Cordieria Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 131, 1884, type (by virtual tautonymy) *Pleurotoma cordieri* Payraudeau, a synonym or variety of *Murex reticulatus* Renier and *Murex purpureus* Montagu; not *Cordieria* Rouault, 1848.

Philbertia Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 132, 1884, type (by virtual tautonymy and subsequent designation) *Pleurotoma bicolor* Risso, of which *Pleurotoma philberti* Michaud is cited by Monterosato in the synonymy; Dall, Proc. U. S. Nat. Mus., Vol. 54, pp. 321, 329, 1918, type cited, *Pleurotoma bicolor* Risso + *philberti* Michaud + *purpurea* (Montagu) Bucquoy, Dautzenberg, and Dollfus var. *bicolor*.

Cirillia Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 133, 1884, type (by virtual tautonymy and subsequent designation) *Murex linearis* Montagu, in the synonymy of which Monterosato cites: "= *P. C.* . . . , (O. G. Costa) Sc. per *Cirilli*, dedicata a Cirillo;" Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 323, 1918, type cited.

Leufroyia Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 134, 1884, type (by virtual tautonymy and subsequent designation) *Pleurotoma leufroyi* Michaud; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 328, 1918, type cited.

Comarmondia Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 135, 1884, new name for *Bellardia* and *Bellardiella*, preoccupied.

Perotoma Harris and Burrows, Eoc. Olig. Beds Paris Basin, p. 113, 1891, new name for *Homotoma* Bellardi, preoccupied.

Pseudodaphnella Boettger, Deutsche Malakozoologische Gesellschaft (Frankfurt-am-Main), Nachrichsblatt, p. 58, 1895; Dall, Proc. U. S. Nat. Mus., p. 330, 1918, type cited *Pleurotoma philippinensis* Reeve.

? Otitoma Jousseaume, Le Naturaliste, Vol. 26, p. 106, May 1, 1898, type (by virtual tautonymy) *Otitoma ottitoma* Jousseaume, described *loc. cit.*, but never figured; Iredale, Proc. Malac. Soc. London, Vol. 12, p. 327, 1917.

Clathurina Melvill, Proc. Malac. Soc. London, Vol. 12, p. 185, 1917, type (by original designation) *Pleurotoma foraminata* Reeve.

Type (by subsequent designation, Monterosato, 1875), *Pleurotoma histrix* Jan = *Raphitoma histrix* Jan in Bellardi, Mem. R. Accad. Sci., Torino, Ser. 2, Vol. 9, p. 613, pl. 4, fig. 14, 1847, = *Pleurotoma hystrix* Cristofori and Jan, Cat. Mus., Vol. 2, Pt. 1, p. 10, 1832, + *Clathurella hystrix* (Jan), Harmer, Mon. Palæo. Soc., Vol. 68, Plio. Moll. Gt. Brit., Vol. 1, p. 240, pl. 28, figs. 24, 25, 1915, Pliocene of England and Italy, living in the Mediterranean.

Shell of medium size, spire moderately high; whorls rounded, sculpture usually in both directions forming a reticulate pattern of raised lines; aperture varying from two-fifths to a half the length of the shell, ovate, outer lip slightly thickened, with at some growth stages a row of very fine denticulations on the inner side, lip rounding back posteriorly to a moderately deep, usually not reinforced posterior notch close to the suture, inner lip not thickened, columella usually somewhat flexuous, anterior canal not wide, usually sharply defined but very short, often notched behind.

Geologic range: Eocene to Recent (Cossmann for *Clathurella*).

Distribution: Tropical and temperate seas of the Old World.

The nomenclature of this genus and of related genera is in an appalling state. The unnecessary succession of generic names proposed for specific synonyms or varieties of *Raphitoma reticulata* (Renier) and *R. purpurea* (Montagu), two forms that are so closely related that it might be better to consider them also as conspecific, and for other distinct but closely related species is a test of anyone's patience. *Pleurotoma hystrix* is merely a variety of *purpurea* or *reticulata* (it is difficult to determine which) in which the sharp axial and spiral cords become pointed at the intersections. Furthermore, the synonymy has been complicated by preoccupied names, by erroneous citations of types, by debatable interpretations of the rules of nomenclature, and most of all by the fact that the genus is difficult to separate from its relatives. It is to be noted here that Bellardi did not cite the type of *Raphitoma* in his preliminary outline of the Pleurotomids, published a few pages ahead of Monterosato's valid designation, for Bellardi had two sections each with a type and did not specify which was the typical section. In *Borsonia,* treated the same way, the typical section comes second.

There is still some doubt about the proper name to use for this much-named group of species. *Pleurotomoides,* like *Lora* and *Clathurella,* was proposed not as a new name for *Defrancia* in a technical sense, but merely as a new genus with *Defrancia* preoccupied in the synonymy and with several species for which the author felt the need of a name cited as examples. It is the writers' opinion that any species so cited as an example at the time of proposing the name is available as type, provided that the new name is not specifically stated to be "a new name for" the older name preoccupied, and that in such case the later name need not necessarily have the same type as the older, unless by chance the same species be selected for both names independently by the ordinary processes of type fixing.

Thus, Cossmann in 1896 cites Carpenter's first species, *Clavatula rava* Hinds, as the type of *Clathurella,* and the writers consider this designation valid. Similarly, in 1925, Dautzenberg and Fischer cite Bronn's first species, *Murex reticulatus* Renier, as the type of *Pleurotomoides;* and the writers believe that if there were no earlier valid designation, *Pleurotomoides* would have to be used here instead of *Raphitoma.* However, in 1908, Dall cited one of Millet's species as the type of *Defrancia* and applied it specifically to *Clathurella.* This action, being later than that of Cossmann, should not affect *Clathurella;* but in 1918, after explaining again that *Defrancia pagoda* is the type of both *Defrancia* and *Clathurella,* Dall states that *Pleurotomoides* "must take precedence over *Clathurella* with the same typical species." Although there may be some question about whether this irregular method of type citing is valid or not, it appears so to the writers, and hence *Pleurotomoides* is here used for the group better known as *Pleurotomella* instead of for *Raphitoma.*[1]

Raphitoma is difficult to separate from a number of other small Turrid genera. It is distinguished from *Clathurella* principally by its larger, relatively thinner, less angulated shells, and by its less heavily armored outer lip and notch; but intergradations occur. It is distinguished from *Pleurotomoides* by its shallower posterior notch, its higher spire, and somewhat heavier shell. *Agathotoma* is smaller, thicker, with different sculpture; and the various forms of *Clavus* usually have larger, heavier shells, with narrower spires and reinforced notches. *Raphitoma* has more of a *Turricula* notch than most of these other groups, but the specific relationships seem to tie it more closely with the *Clavus* branch of the family.

Some of the names cited above in the synonymy of this genus have been commonly applied to species occurring on the Pacific coast of North America; but very few of these species, if any, fall within the genus as now restricted. In the middle Miocene of the San Joaquin basin, California, there is a species known as *dumbleanus,*[2] which was first referred to *Clathurella* and is more like *Raphitoma* in sculpture and shape than any other California species. Nevertheless, it lacks the Turrid notch entirely and shows a weak siphonal fasciole, so that, as Anderson later pointed out, it is probably a *Phos* and belongs to the *Nassariidæ.*

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[1] A similar nomenclatorial problem appears in the case of *Eucithara* Fischer (*Cythara* Schumacher not Klein), and the reader may be interested to compare the interpretation of that case.

[2] *Pleurotoma (Clathurella) dumblei* Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 2, p. 204, pl. 15, figs. 60, 61, 1905, not *Pleurotoma (Drillia) dumblei* Harris, 1895.

Phos dumbleana Anderson in Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 183, 1924.

Genus PERRONA Schumacher, 1817

Perrona Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 66, 218, 1817; Tryon, Man. Conch., Vol. 6, p. 231, 1884; Cossmann, Ess. Paléo. Comp., Vol. 2, p. 68, 1896.

Tomella Swainson, Treat. Malac., pp. 115, 314, 1840, original list comprises *lineata* Lamarck, *clavicularis* Lamarck, *filosa* Lamarck, and *lineolata* Lamarck; type (by subsequent designation, Herrmannsen, Ind. Gen. Malac., Vol. 2, p. 579, Feb., 1849) *Pleurotoma lineata* Lamarck, figured by Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Pleurotome*, p. 47, pl. 22, fig. 1, 1839-40, by Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 11, species 96, 1843, and by Tryon, Man. Conch., Vol. 6, p. 231, pl. 8, figs. 10, 11, 1884; not *Tomella* Rob.-Desv., 1830, genus of Diptera (*fide* Herrmannsen).

Pusionella Gray, Proc. Zool. Soc. Lond., p. 137, 1847, type (by original designation) *Murex pusio* Born = *P. nifat* (Adanson) Bruguière, + *Buccinum pusio* Born and Gmelin, not Linnæus, figured by Kiener, Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Fuseau*, p. 42, pl. 23, figs. 1, pl. 24, figs. 2, 1840, by Reeve, Conch. Icon., Vol. 4, *Fusus*, pl. 7, species 30, 1847, and by Tryon, Man. Conch., Vol. 6, p. 235, pl. 31, figs. 13, 14, 1884. *Perrona nifat* is also illustrated here, plate 25, figures 12*a*, 12*b*.

Netrum Philippi, Abb. u. Beschr. Conchyl., p. 118, 1850, type *Fusus nifat* Adanson (*fide* Dall, 1918).

Type (by monotypy), *Perrona tritonium* Schumacher = *Murex perron* Chemnitz, Neues Syst. Conch. Cab., Vol. 10, p. 278, pl. 164, figs. 1573, 1574, 1788, = *Pleurotoma perronii* Reeve, Conch. Icon., Vol. 1, pl. 11, species 94, 1843, also figured by Tryon, Man. Conch., Vol. 6, p. 232, pl. 8, fig. 8, 1884, living, west Africa.

Shell typically the shape of a typical *Clavatula*, but often becoming round-whorled with a much longer or a much shorter columella; sculpture entirely obsolete or with faint remnants of the *Clavatula* ribs or spirals, especially on the early whorls; posterior notch about the middle of the outer lip and varying in strength from a deep, angular recession in the lip and in the growth lines to a mere obscure flexure; inner lip with a mound of shelly material immediately below the suture in species or varieties that have high-shouldered whorls.

Geologic range: Miocene to Recent.

Distribution: Tropical waters of all oceans.

The transition from *Clavatula* to this genus, which takes place through the loss of sculpture, is very easy to see, especially in view of the European Miocene species, *Clavatula tuberculosa* (Grateloup) and *C. spinosa* (Grateloup) (figured by Cossmann, *op. cit.*, pl. 4, fig. 19), in which the change can be seen going on. The type species has cylindrical or concave-sided whorls, each whorl with a high shoulder (from which the spines of *C. spinosa* have disappeared) and an obscure lower angle, the V-shaped notch being midway between the shoulder and the lower angle. From the typical form the series of variations is unbroken through *Perrona nifat* variety *scalarina* (Lamarck) to *P. nifat*, *s. s.*, the type of *Pusionella*. The shouldered form of *scalarina* is separable only specifically from *P. perron*, and the gradation from *scalarina* to the smoothly round-whorled typical variety offers no opportunity for separation. Hence, *Pusionella* must be considered a synonym of *Perrona*. Other species closely allied to *P. nifat*, such as *P. subgranulata* (Petit) and *P. aculeiformis* (Lamarck), resemble *Terebra* so much in general appearance that Cossmann classified *Pusionella* with the *Terebridæ* (*op. cit.*, p. 56). However, Thiele[1] has described and figured the radula of *P. nifat*, as well as that of *P. lineata* (Lamarck), the type of *Tomella* Swainson, and finds that both of them agree with the radula of *Clavatula;* and if you hold in mind the genetic series described above, it is easy to see how these forms with a *Terebra*-like appearance can be so closely related to *Clavatula*. *Tomella* represents the other extreme, derived from typical *Perrona* by the lengthening instead of the shortening of the canal. In the shouldered species of *Perrona*, such as *P. rapulum* (Reeve), there is a mound of shelly material at the top of the inner lip, and this mound is entirely analogous to that found in *P. lineata*. In no respect is *Tomella* essentially distinct from *Perrona*, as is stated by Casey,[1] and hence no new name is proposed as a substitute for Swainson's name, which appears to be preoccupied. Cossmann and Tryon both put *Tomella* in the synonymy, and Reeve figures a variety of *lineata* which connects it with the more typical forms of *Perrona* (Conch. Icon., Vol. 1, *Pleurotoma*, pl. 11, species 96*a*, 1843). The group of forms here included in *Perrona*, though covering a wide range of variations, is a natural, well-defined unit; and it would be contrary to the facts of nature to subdivide it. Illustrations of *Perrona nifat* and of *Perrona obesa* (Reeve), a more typical *Perrona*, are shown on plate 25, figures 12*a*, 12*b*, and 13*a*, 13*b*, respectively.

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[1] Thiele, Wiss. Erg. Deutsch. Tiefsee-Exped., Vol. 17, p. 204, 1925.

Family CANCELLARIIDAE

Genus CANCELLARIA Lamarck, 1799

Cancellaria Lamarck, Mém. Soc. Hist. Nat. Paris, p. 71, 1799; Syst. Anim. s. Vert., p. 76, 1801; Tryon, Man. Conch., Ser. 1, Vol. 7, pp. 65, 66, 1885; Cossmann, Ess. Paléo. Comp., Vol. 3, p. 10, 1899.

Cancellarius Montfort, Conchyl. Syst., Vol. 2, pp. 562, 563, 1810.

Buccinella Perry, Conch., pl. 27 and text, in part, April, 1811.

Merica H. and A. Adams, Gen. Rec. Shells, Vol. 1, p. 277, January, 1854.

Euclia H. and A. Adams, *op. cit.*, p. 277, 1854.

? *Aphera* H. and A. Adams, *op. cit.*, p. 277, 1854, only species, *C. tessellata* Sowerby.

Excchoptychia Cossmann, Ess. Paléo. Comp., Vol. 5, pp. 189, 190, 1903.

Type (by monotypy), *Voluta reticulata* Linnæus, figured by Tryon, Man. Conch., Ser. 1, Vol. 7, pl. 2, figs. 25, 26, 1885, Florida and West Indies, Recent.

Shell oval, cancellated, ribbed, reticulated, or nearly smooth; last whorl ventricose; aperture oblong, with a short anterior canal, sometimes recurved; columella with strong, oblique plaits, usually two.

In view of the individual variability of some species of *Cancellaria*, it is apparent that the California species have been overnamed. It is likely that habitat has some influence on the shape of the shell and the sculpture, and possibly sexual dimorphism is a factor. It is believed that in many cases the subgeneric and minor subdivisions of *Cancellaria* will prove more artificial and confusing than natural. These latter have likewise been overnamed.[2]

Section Cancellaria, s. s.

Shell rather heavy, ovate, with reticulate sculpture; columella with two strong, nearly horizontal plaits above the plait-like end of the columella.

Cancellaria obesa Sowerby

Cancellaria obesa Sowerby, Proc. Zool. Soc. London for 1832, p. 52, 1832; Thes. Conch., Vol. 2, p. 441, pl. 93, fig. 37, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 2, fig. 7, 1856; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 68, pl. 2, figs. 17, 18, questionably 19, 1885; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 210, 1909; Nautilus, Vol. 32, p. 23, 1918; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 154, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 444, pl. 20, figs. 3, 4, 1926; Hanna and Hertlein, Vol. 16, p. 142, 1927.

Cancellaria ovata Sowerby, Proc. Zool. Soc. London for 1832, p. 53, 1832; Thes. Conch., Vol. 2, p. 441, pl. 92, fig. 2, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 4, fig. 18, 1856.

? *Cancellaria acuminata* Sowerby, Proc. Zool. Soc. London for 1832, p. 53, 1832; Thes. Conch., Vol. 2, p. 458, pl. 92, fig. 1, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 1, figs. 4*a*, 4*b*, 1856; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 69, pl. 2, fig. 19, 1885.

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[1] Casey, T. L.: Trans. Acad. Sci. St. Louis, Vol. 14, p. 126, 1904.

[2] Dall remarked upon the "totally unnecessary number of names" that have been applied to the subdivisions of *Cancellaria*. (U. S. Geol. Survey, Prof. Paper 59, p. 30, 1909.)

Shell ovate, heavy, with reticulate sculpture variable in strength and character; aperture elongate, narrow at the top, outer lip lirate within, columella with two strong, nearly horizontal plaits, sometimes an intercalary plait, and a plait-like lower margin; umbilical chink often present.

Pliocene: Imperial formation of Carrizo Creek region, western Imperial County (Hanna); Coronados Island, Gulf of California (Hanna and Hertlein).
Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918).
Recent: Point Abreojos, Lower California (Hemphill), and Gulf of California, Mexico, to Guayaquil, Ecuador.

This well-known southern species usually has a low spire with a relatively enormous but moderately ventricose body whorl. The higher spired form was named *acuminata* by Sowerby and may prove to be a variety. *C. obesa* is closely related to *C. urceolata* Hinds. Hanna remarked on the variability of the Pliocene specimens from the Imperial formation, some of which have the sculpture of *C. urceolata* Hinds while others seem to be rather typical forms of *obesa*.

Cancellaria obesa Sowerby variety **planospira**, new variety

Plate 27, Figure 4

Shell small, elongate-ovate, body whorl moderately ventricose, upper whorls very slightly convex; sculpture finely and evenly reticulate, about eleven spiral riblets on back of body whorl, obsolete near suture; aperture ovate, not so elongate as in typical *obesa;* columella with two small, oblique plaits, with the margin plait-like, and the upper plait possibly double.
Dimensions: Length, 23 mm.; diameter of body whorl, 13 mm.; length of aperture, about 10 mm.

Type specimen: In the collection of the San Diego Society of Natural History, No. 266.

Type locality: Locality 216 S. D. S. N. H., lower Pliocene, east of Fernando Pass, Los Angeles County.

Pliocene: Lower Pliocene of the type locality and of Elsmere Canyon, Los Angeles County (H. R. G.).

This form does not appear to be the young of the other species of *Cancellaria* from nearby localities. It is something like *C. reevana* Crosse except that the spiral lines are fewer and coarser. In some aspects it recalls *C. purpuriformis* Kiener.

Cancellaria urceolata Hinds

Cancellaria urceolata Hinds, Proc. Zool. Soc. London for 1843, p. 47, October, 1843; Zool. Voy. *Sulphur*, Moll., p. 41, pl. 12, figs. 7, 8, 1844; Sowerby, Thes. Conch., Vol. 2, p. 443, pl. 94, fig. 48, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 5, figs. 23*a*, 23*b*, 1856; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 69, pl. 2, fig. 20, 1885.

"*Cancellaria candida* Sowerby," Dall, Nautilus, Vol. 32, p. 23, 1918; probably not *C. candida* Sowerby, Conch. Illust., sp. 2, fig. 1, 1832 (?), "Polynesia;" Thes. Conch., Vol. 2, p. 442, pl. 92, fig. 8, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 10, figs. 46*a*, 46*b*, 1856, "Polynesia;" Tryon, Man. Conch., Ser. 1, Vol. 7, p. 69, pl. 2, fig. 21, 1885, "Polynesia."

Shell resembling *obesa* but higher spired; whorls somewhat roundly tabulated above; sculpture of spiral riblets and axial folds; aperture ovate and not narrowly prolonged above; outer lip lirate within, columella with two strong, nearly horizontal plaits. Length, 32 mm.; diameter, 18 mm.

Type locality: Of *urceolata*, San Blas, Mexico, Recent (of *candida* Sowerby, "Polynesia").

Pleistocene: At Magdalena Bay, Lower California, Mexico (Dall, as *C. candida* Sowerby).
Recent: West coast of Central America to Mazatlan, Mexico (Tryon).

This species can generally be distinguished from *obesa* by the sloping and often partially rounded tabulation below the suture, the more prominent axial sculpture, which is sometimes fold-like, the higher spire, and the less narrow and less elongate aperture. *C. obesa* appears to attain a larger size, one Recent specimen from Santa Inez, Lower California, measuring nearly 60 mm. in length and about 33 mm. in diameter. The aperture of large specimens of *obesa* is narrowly elongated above, but this feature is not developed in the immature shells.

C. candida Sowerby, as figured, is a lighter colored shell than *urceolata*. It is supposed to come from Polynesia.

Section CRAWFORDINA Dall, 1918

Crawfordina Dall, Proc. Biol. Soc. Washington, Vol. 31, p. 138, Nov. 29, 1918; Proc. U. S. Nat. Mus., Vol. 56, p. 306, 1919.

Type (by original designation), *Cancellaria crawfordiana* Dall.

Shell elongate-ovate, with axial and spiral sculpture; columella long, with two oblique plaits above the plait-like end of the columella and sometimes small supplementary plaits.

This section differs from *Cancellaria, s. s.*, in the more elongate shape, lighter weight, smaller, more oblique plaits, and shorter columella.

Cancellaria crawfordiana Dall

Cancellaria crawfordiana Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 182, pl. 6, fig. 1, 1891; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 217, 1903; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 43, 1913; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 341, pl. 39, figs. 9*a*, 9*b*, 1918; Oldroyd, Stanford Univ. Publ. Geol., Vol. 1, p. 153, 1927.

Cancellaria crawfordiana Dall, var. *fugleri* Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, pp. 15, 16, pl. 54, fig. 9, 1907.

Cancellaria oregonensis Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 28, 29, pl. 2, fig. 7, April 2, 1909, not *Cancellaria ? oregonensis* Conrad, Amer. Journ. Conch., Vol. 1, p. 151, 1865, referring to the U. S. Expl. Exped., Geol. Atlas, pl. 20, fig. 8.

Cancellaria oregonsis Dall, *op. cit.*, expl. plate, *err. pro oregonensis*, 1909.

Progabbia crawfordiana Dall, U. S. Nat. Mus., Bull. 112, p. 84, 1921.

Cancellaria fugleri Arnold, Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 51, pl. 1, fig. 3, 1926.

Cancellaria oldroydia Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 51, pl. 1, fig. 5, May 31, 1926.

Shell of moderate size, rather thin; whorls six, convex, suddenly becoming more convex at the top and plunging over into the channeled suture; spiral sculpture of about twenty small ridges, narrower than the interspaces, eight or nine of which are visible on the upper whorls; axial sculpture of about twenty riblets, slightly stronger than the spiral ridges; columella straight, callus thin, with two sharp folds and occasionally small secondary folds; outer lip thin, lirate within; siphonal fasciole moderate, umbilicus generally absent or covered by callus.

Dimensions of a mature Recent specimen: Length, 52 mm.; diameter, 25 mm.; length of aperture, 25 mm.

Type specimens: Of *crawfordiana*, *oregonensis*, and *fugleri*, in the U. S. National Museum; of *oldroydia*, in the collection at Stanford University.

Type localities: Of *crawfordiana*, Drake's Bay, near San Francisco, Recent; of *oregonensis*, Coos Bay, Oregon, Empire formation, upper Miocene; of *fugleri*, one mile north of Gary, Santa Barbara County, lower Pliocene; of *oldroydia*, near mouth of Purisima Creek, San Mateo County, Pliocene.

Miocene: Empire formation of Coos Bay, Oregon (Dall, as *oregonensis*).

Pliocene: Purisima formation at its type locality, Purisima Creek, San Mateo County (Carson, as *oldroydia*); Fugler's Point asphalt mine, Santa Barbara County (Arnold, as variety *fugleri*); excavation at Fourth and Broadway, Los Angeles (Moody, as *crawfordiana*).

Pleistocene: Rare in upper San Pedro series at San Pedro (Arnold, 1903, as *crawfordiana*).

Recent: Bodega Bay to San Diego, California (Dall, 1921).

Figures of the type of *crawfordiana* and the type of *oregonensis* lead one to suppose that these two forms are distinct, but a study of a collection of fossil and Recent specimens shows that the differences are not significant. Erosion of the surface of the shell changes the aspect of the sculpturing considerably, and variations in the fossils seem to be rather closely paralleled in the Recent specimens. The name *oregonensis* is preoccupied in *Cancellaria*, whether Conrad's species is a *Trichotropis* or not.

Section NARONA H. and A. Adams, 1854

Narona H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 277, January, 1854; Cossmann, Ess. Paléo. Comp., Vol. 3, p. 5, April, 1899.

Progabbia Dall, Proc. Biol. Soc. Washington, Vol. 31, p. 138, November 29, 1918; Proc. U. S. Nat. Mus., Vol. 56, p. 306, August, 1919.

Type (by subsequent designation, Cossmann, 1899), *Cancellaria clavatula* Sowerby, 1832; Thes. Conch., Vol. 2, p. 445, pl. 92, fig. 13, pl. 95, fig. 67, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 11, figs. 52*a-c*, 1856; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 75, pl. 4, fig. 61, 1885; Panama to Paita, Peru; Recent; also Pliocene of California.

Shell elongate-ovate, typically with axial folds, which are sometimes reduced to nodes on the upper parts of the whorls, or with strong nodes or blunt spines on the shoulders, and with spiral ribs; columella with two very oblique folds.

It is impossible to use all the subdivisions of *Cancellaria* that have been proposed in the literature. Some of the characters upon which the subdivisions have been founded occur sporadically among a number of species which are not uniformly closely related, and even combinations of characters (generally more reliable than single characters) do not always furnish the key to a natural grouping of the subgenera and sections. It is possible that the anatomical characters, when well enough known, will permit of a natural subdivision of the genus; but such a subdivision would be of little service to those who must study extinct fossil forms, unless the distinctive anatomical features can be correlated with shell characters. Until the genus has been critically monographed, it is more conservative to use broadly the early-proposed names than to delimit these names too closely, for the recently coined names apply to very minor groups and often mean little or nothing biologically. The creation of superfluous names usually complicates the literature, leads to confusion through differences of opinion among authors, and conceals the real geologic and geographic relationships of small groups of species, all for the sake of differences in taxonomy which are not differences in phylogenetic relationships.

Cancellaria clavatula Sowerby

Plate 27, Figure 2

Cancellaria clavatula Sowerby, Proc. Comm. Sci. Zool. Soc. London for 1832, p. 52, June, 1832; Thes. Conch., Vol. 2, p. 445, pl. 92, fig. 13, pl. 95, fig. 67, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 11, figs. 52*a-c*, 1856; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 75, 1885; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 209, 1909.

Shell fusiform to elongate-ovate, spire high, acute; sculpture of spiral threads and axial folds or ribs with occasional heavier, varix-like ribs; aperture ample, not narrowed above; columella tenuous at the end, with two very oblique plications.

Pliocene: Basal Pliocene of loc. 216, east of Fernando Pass, Los Angeles County (H. R. G.).
Recent: Panama to Paita, Peru (Dall, 1910).

The specimen figured is much like Reeve's figure 52*a*, and although the occurrence is far from the known habitat, the specimen does not seem to differ sufficiently to warrant a distinct name. It is possible that *clavatula* ranges a considerable distance north of Panama.

Cancellaria tritonidia and *C. cooperi* are larger and the axial sculpture is emphasized on the upper portion of the whorls in the production of nodosities.

Cancellaria elsmerensis English

Cancellaria elsmerensis English, Univ. Calif. Publ. Geol., Vol. 8, p. 216, pl. 23, fig. 8, 1914.

Shell fusiform, spire elevated, whorls five to six; whorls of spire angulated, angulation absent on the body whorl; whorls ornamented by ten to twelve longitudinal ridges, on the body whorl these ridges becoming low and irregular in shape; whorls with three or four faint spiral lines which are absent on the body whorl except for a small area on the posterior part of the columella; aperture oval; outer lip thin; columella encrusted, smooth except for two acute plications anteriorly, callus extending above the suture; canal short, straight. Altitude, 25 mm.; width, 12 mm.; width of aperture, 5 mm.; length of aperture, equal to half the total height of shell.

Type specimen: In the University of California collection.

Type locality: Elsmere Canyon, Los Angeles County, lower Pliocene.

Pliocene: Lower Pliocene of the type locality.

English compared this species to *C. cooperi* Gabb, from which he stated it differed in its smaller size, in the absence of angulation on the body whorl, and in the irregular ridges and growth lines on the body whorl. It may be close to *C. clavatula* Sowerby, part of its difference in appearance being due to erosion. It seems to be a rare species. When more specimens are known, its relationships with other species may be revealed.

Cancellaria tritonidea Gabb

Plate 27, Figure 8

Cancellaria (*Euclia*) *tritonidea* Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 11, pl. 2, fig. 18, 1866, p. 79, 1868-9.

Cancellaria tritonidea Gabb, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 231, 1888; Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 183, 1891; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 218, pl. 7, fig. 5, 1903; U. S. Geol. Surv., Bull. 396, pp. 31, 158, pl. 26, fig. 10, January 15, 1910; Bull. 398, pl. 48, same figure, 1910; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; McLaughlin and Waring, Calif. State Mining Bureau, Bull. 69, Map Folio, pl. 1, fig. 51, 1914; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 220, table opp. p. 230, 1917; Waterfall, Vol. 18, pp. 77, 78, 79, 1929.

Cancellaria perrini Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 56, pl. 3, fig. 4, 1926.

Shell large, fairly heavy, whorls about six, body whorl large; all of the whorls more or less angulated, the shoulder appearing at about the middle of the exposed part of the upper whorls and about a quarter of the distance below the suture of the body whorl; sculpture of about seventeen fairly coarse spiral lines below the shoulder, the number sometimes increased by intercalaries on the body whorl of large specimens, and of about six spiral lines above the shoulder; axial ridges or folds more or less clearly developed, finer and more closely spaced on the earlier whorls so that the axial and spiral sculpture there usually form a nearly equal warp and woof, on later whorls the ridges tending to grow sharper or to die out in broad folds, averaging twelve on the body whorl and eighteen on the penultimate whorl; the ridges or folds often developing into prominent nodes on the shoulder; suture distinct, abutting sometimes against the shoulder, sometimes against the wall of the preceding whorl; columella covered with a heavy callus, which sometimes extends above the body whorl, showing above the suture on some of the earlier whorls; columella with two strong plaits, sometimes straight and simple, with a moderate siphonal fasciole, sometimes swollen and recurved, with one or two indistinct minor plaits and occasionally a marked umbilical chink partially covered over by the callus; outer lip simple; posterior canal a shallow inverted trough; anterior canal rounded, shallow, narrow, and short, sometimes slightly recurved.

Single specimens of the varieties of *Cancellaria tritonidea* appear rather distinct, but large collections generally show intergradation between all of them. Many of the varieties occur in the same deposit. At one time Dall (1914) considered *C. tritonidea* and *C. vetusta* Gabb the young and the gerontic individuals, respectively, of *C. cassidiformis* Sowerby; but this is a rather extreme view.

Variety **tritonidea**, s. s.

Spire comparatively low; early whorls with nearly equal axial and spiral sculpture, convex; later whorls with strong angulation, slightly concave above the shoulder; prominent nodes along the shoulder on the axial folds, which are distinguishable nearly to the base of the body whorl.

Dimensions (from Arnold, 1903): Longitude, 90 mm.; diameter of body whorl, 60 mm.; length of aperture not including canal, 50 mm.; apical angle, 75 degrees.

Type specimen: In the University of California collection, No. 11,998.

Type locality: San Pedro, presumably Pleistocene.

Pliocene: Lower Pliocene at Elsmere Canyon, Los Angeles County (English, 1914; Carson, as *C. perrini*); *Pecten coalingensis* zone of Coalinga region; upper Sargent of San Benito County (Nomland, 1917); "Pico" formation of Ventura region (Waterfall).

Pleistocene: Coyote Creek, Ventura County, and San Pedro (Cooper); Barlow's Ranch, just east of Ventura (Arnold, 1903); "Saugus" near Ventura (Waterfall); San Pedro, presumably Pleistocene (Gabb); rather rare in the upper San Pedro series of San Pedro (Arnold, 1903).

Typical *Cancellaria tritonidea* Gabb ranges from the lower Pliocene to the upper Pleistocene but is absent in the cold-water zones of the Pleistocene of southern California. The folds on the body whorl of the type of *perrini* are well hidden within the aperture. The variety *rapa* Nomland differs in the lack of nodes and axial folds on the later whorls, and in the weaker angulation. The specimen named *perrini* is somewhat intermediate between *tritonidea*, *s. s.*, and variety *rapa* but is closer to the former.

Cancellaria tritonidea Gabb variety **rapa** Nomland

Cancellaria rapa Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 240, pl. 11, figs. 1, 1*a*, 1917.
Cancellaria elodiæ Carson, Bull. Southern Calif. Acad. Sci., Vol. 25, p. 49, pl. 1, fig. 1, 1926.
Cancellaria palmeri Carson, *op. cit.*, p. 55, pl. 2, fig. 4, 1926.

Like *tritonidea*, *s. s.*, but lacking the nodes and axial folds on the later whorls; angulation on the shoulder of the whorls less and the sutures more nearly tangential.

Type specimens: Of *rapa*, in the University of California collection, No. 11,097; of *elodiæ* and *palmeri*, in the Stanford University collection, Nos. 109 and 107, respectively.

Type localities: Of *rapa*, near Coalinga, Pliocene (?), *fide* Nomland; of *elodiæ*, Fugler's Point, Santa Barbara County, Pliocene; of *palmeri*, beach bluffs at Capitola, Santa Cruz County, Purisima formation, Pliocene.

Pliocene: At the type localities, as above.

The paratype of *C. hamlini* Carson has some resemblance to this variety. The lack of nodes and axial folds on the variety *rapa* may be merely a function of the more rounded whorls.

Cancellaria tritonidea Gabb variety **hamlini** Carson

Cancellaria hamlini Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 51, pl. 1, figs. 4, 6, 1926.

Shell like that of the variety *rapa* but with more delicate sculpture and the shape more tapering as in the variety *altispira*.

Type specimen: In the collection at Stanford University, No. 110.

Type locality: Elsmere Canyon, Los Angeles County, lower Pliocene.

Pliocene: Lower Pliocene of the type locality.

The type of *hamlini,* which is a young specimen, bears a superficial resemblance to *C. crawfordiana* Dall, but the strongly rounded shoulders and channeled sutures of the latter suffice to distinguish it.

Cancellaria tritonidea Gabb variety **altispira** Gabb

Plate 27, Figure 7

Cancellaria altispira Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 50, 79, pl. 14, fig. 7, 1868-9.

Cancellaria newhallensis Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 56, pl. 3, fig. 3, 1926.

Cancellaria (Progabbia) altispira Gabb, Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, pp. 411, 412, pl. 31, figs. 9, 9*a*, 1927.

Shell like that of *tritonidea, s. s.*, but with a proportionately higher spire, which is about as long as the aperture, and with a less expanded body whorl. Length, 50 mm.; diameter of body whorl, 30 mm.; apical angle, 55°.

Type specimens: Of *altispira,* in the Museum of Comparative Zoology of Harvard University, Whitney Collection, No. 27,812, *fide* Stewart; of *newhallensis,* in the collection at Stanford University, No. 108.

Type localities: Of *altispira,* San Fernando Pass, Los Angeles County, Pliocene; of *newhallensis,* Elsmere Canyon, Los Angeles County, Pliocene.

Pliocene: Lower and middle Pliocene at and near the type localities (Gabb; Carson).

The sculpture of the upper whorls of the types of both *altispira* and *newhallensis* recalls *C. crawfordiana.* Individuals of *Cancellaria spengleriana* Deshayes of the Japanese fauna that are not fully mature are very similar to variety *altispira.*

Cancellaria tritonidea Gabb variety **fernandoensis** Arnold

Plate 27, Figure 1

Cancellaria fernandoensis Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 535, pl. 50, fig. 4, June 15, 1907; U. S. Geol. Surv., Bull. 309, pl. 40, fig. 4, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914.

Cancellaria quadrata Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 56, pl. 1, fig. 6, 1916, not *Cancellaria quadrata* Sowerby, Min. Conch. Gt. Brit., Vol. 4, p. 83, pl. 360, 1823.

Cancellaria fernandoensis tribulus Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 238, pl. 12, figs. 1, 1*a*, 1917, not *Voluta tribulus* Brocchi, 1814, a *Cancellaria.*

Cancellaria angelana Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 159, March 18, 1924, new name for *C. quadrata* Moody.

Shell like that of the typical variety of *tritonidea* but with stronger axial ribbing on the earlier whorls.

Type specimens: Of *fernandoensis,* in the U. S. National Museum, No. 164,956; of *quadrata* Moody, in the collection at the University of California, No. 11,083; of *tribulus* Nomland, in the same collection, No. 11095.

Type localities: Of *fernandoensis,* Elsmere Canyon, near Pacific Coast Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, lower Pliocene; of *quadrata* Moody, Fourth and Broadway, Los Angeles, upper or upper middle Pliocene; of *tribulus* Nomland, Garza Creek, Kings County, San Joaquin Valley, *Turritella nova* zone, lower middle Pliocene.

Pliocene: Lower Pliocene of Elsmere Canyon (Arnold; English), and of S. D. S. N. H. loc. 216, east of Fernando Pass, Los Angeles County (H. R. G.); middle Etchegoin of Kings County (Nomland, as variety *tribulus*); upper or upper middle Pliocene of Los Angeles (Moody, as *quadrata*).

The type of this variety lacks the adult body whorl. The variety *fernandoensis* is possibly of more value than some of the others here recognized, but is clearly not a distinct species. The upper whorls of some specimens of *tritonidea* look much like Arnold's type figure of *fernandoensis*.

Cancellaria tritonidea Gabb variety **crassa** Nomland

Cancellaria crassa Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 237, pl. 12, figs. 7, 7*a*, April 19, 1917.

Shell like that of variety *fernandoensis* but with fewer and stronger axial ribs.

Type specimen: In the collection at the University of California, No. 11,098.

Type locality: On the north bank of Waltham Creek, Coalinga district, *Turritella nova* zone, lower middle Pliocene.

Pliocene: At the type locality. (Nomland).

The appearance of the type of this variety is quite different from that of typical specimens of *C. tritonidea;* but when all the variants of the species are studied together, it is very hard to decide where to draw the line between valid and invalid distinctions. Until much larger collections of *C. tritonidea* and its variants are available for study it must remain to some extent a matter of personal opinion whether this or that form is synonymized or kept distinct. Possibly too many varieties of *tritonidea* have been here recognized, but at least a first step has been taken in disposing of too many names.

The group to which *Cancellaria tritonidea* and its varieties belong is represented in the lower Miocene (in part Oligocene) by *Cancellaria vetusta* Gabb[1] and its allies, including *C. andersoni*[2] and *C. ramonensis* Clark.[3]

Cancellaria cooperi Gabb

Cancellaria (*Narona*) *cooperi* Gabb, Proc. Calif. Acad. Sci., Vol. 3, p. 186, 1865.

Cancellaria cooperi Gabb, Tryon, Man. Conch., Ser. 1, Vol. 7, p. 76, pl. 4, fig. 66, 1885; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 211, pl. 22, fig. 2, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 217, pl. 7, fig. 8, 1903.

Cancellaria (*Progabbia*) *cooperi* Gabb, Dall, U. S. Nat. Mus., Bull. 112, p. 83, pl. 5, figs. 3, 4, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 152, pl. 11, fig. 14, 1927.

Shell large, elongate; whorls six, angulated at the upper third of the exposed portion, sometimes the lower two-thirds divided by a slightly stronger spiral line; spiral sculpture finer but otherwise much like that of *C. tritonidea;* axial sculpture of prominent, varix-like ribs, about fifteen on every whorl except the first, which is usually worn smooth and the last, on which the ribs sometimes degenerate into irregular folds and growth lines; columella heavily encrusted with callus, bearing a prominent fold just above the middle and two oblique plications below the middle; outer lip internally lirate.

Dimensions: Longitude, 80 mm.; diameter of body whorl, 35 mm.; length of aperture including canal, 42 mm.; apical angle, 40°.

Type specimen: "In Geological Survey, Mollusca Survey Cabinet, No. 463," *fide* Oldroyd (= University of California collection ?).

Type locality: San Diego; Recent.

Pleistocene: "Rare in the upper San Pedro series of San Pedro; five specimens found" (Arnold).

Recent: Monterey, California, to Coronado Islands off San Diego (Dall).

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[1] Geol. Surv. Calif., Palaeo., Vol. 2, p. 12, pl. 2, fig. 19, 1866.

[2] Clark, Univ. Calif. Publ. Geol., Vol. 11, pp. 80, 82, 97, pl. 23, fig. 4, 1918.

[3] *op. cit.*, p. 186, pl. 23, fig. 7, 1918.

This species is a large, high-spired form. Dall made it the type of *Progabbia*, a subdivision that appears to be entirely unnatural, for *cooperi* is very closely related to *tritonidea*, and might even be considered a variety of *tritonidea*. *C. spengleriana* Deshayes,[1] of the Oriental Pacific fauna, is of the same clan.

Cancellaria fergusoni Carson

Cancellaria fergusoni Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 53, pl. 1, figs. 7, 8, 1926.

Shell like that of *Cancellaria cooperi* but lower spired, with fewer and weaker axial ribs.

Type specimen: In the collection at Stanford University, No. 106.

Type locality: Barlow's Ranch, just east of Ventura, probably Pleistocene (see discussion below).

Pliocene: Fugler's Point, Santa Barbara County (Carson).
Pleistocene: Barlow's Ranch, near Ventura (stated to be Pliocene by Carson).

This *Cancellaria* might be considered a variety of *cooperi*, but it has some resemblance to *altispira* Gabb. *C. cooperi* has more numerous axial ribs (about fifteen to a whorl) than the type of *fergusoni* (which has ten axial ribs per whorl). Until its relationships are better understood, it is tentatively retained as a distinct species.

The holotype is labeled as having come from "Upper San Pedro beds, Barlow's Ranch, Ventura County" collected by Delos Arnold, though Carson attributes an upper Pliocene age to the specimen. The discrepancy may be due to the varying opinions regarding the age of the upper marine sands in the foothills at Ventura.

Cancellaria sanctæ-mariæ Carson

Cancellaria sanctæ-mariæ Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 57, pl. 3, fig. 5, 1926.

Shell short, fusiform, with a sloping, slightly concave tabulation on the upper part of the whorls, suture appressed; sculpture of fine spiral threads, each fourth thread slightly accentuated, and of low, slightly noded axial ribs on the upper whorls, becoming obsolete on the body whorl; aperture oval, columella with two plications, the lower very oblique and tending to become distinct from the lower margin of the columella, the upper only slightly oblique.
Dimensions: Height, 43 mm.; diameter, 23 mm.; apical angle, about 62°.

Type specimen: In the collection at Stanford University, No. 101.

Type locality: Fugler's Point, Santa Maria district, Santa Barbara County; Pliocene, presumably lower part.

Pliocene: Fugler's Point, Santa Barbara County, lower or middle Pliocene (type locality).

The subdued axial sculpture and fine spiral threads serve to distinguish this form. It may prove to be but a variety of *fergusoni*, from which it differs in the very subdued nodosity on the shoulder. It differs from *C. tritonidea* var. *rapa* Nomland in its much finer spiral sculpture and in the more definite shoulder on the whorls.

Cancellaria cassidiformis Sowerby

Cancelloria cassidiformis Sowerby, Proc. Comm. Sci. Zool. Soc. London for 1832, p. 53, June, 1832; Thes. Conch., Vol. 2, p. 439, pl. 92, fig. 15, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 2, figs. 8*a*, 8*b*, 1856; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 66, pl. 1, fig. 1, 1885; Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 183, 1891; Vol. 37, p. 209, 1909; Nautilus, Vol. 32, p. 23, 1918.

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[1] Ency. Méth., Vol. 2, Pt. 1, p. 185, 1830.

Shell short, plump, spire relatively low but sharp apically; whorls tabulated or shouldered; sculpture consisting of spiral cords, alternate cords often more emphasized, and axial ribs which become sharp nodosities on the margin of the tabulation; aperture ovate, with two prominent, oblique plaits, the lower one more oblique than the upper and the lower margin of the columella often plait-like; parietal wall with a callosity; umbilicus closed or but a mere chink.
Length, 40 to 60 mm.; width, 25 to 40 mm.

Type locality: Panama, Recent.

? Pliocene: Santa Barbara County (Dall, 1891, see discussion below).
Pleistocene: Magdalena Bay, Lower California (Dall, 1918), and about seven miles north of Turtle Bay, Lower California, Mexico (in the collection of A. M. Strong, presumably Pleistocene).
Recent: Gulf of California, Mexico, to Paita, Peru (Dall, 1909).

C. cassidiformis is a close relative of *C. vetusta*, *C. tritonidea*, and their allies. Dall stated (1891) that *cassidiformis* occurs as a "fossil in the Miocene or Pliocene formation of Santa Barbara County," and that *C. tritonidea* and *C. vetusta* were "based on a young and a very aged specimen, respectively, of this variable species." *Cancellaria triangularis* Nelson,[1] of the Peruvian Neocene, is also closely related.

Cancellaria hemphilli Dall

Plate 27, Figures 3, 15*a*, 15*b*

Cancellaria hemphilli Dall, U. S. Geol. Surv., Prof. Paper 59, p. 30, pl. 14, fig. 5, April 2, 1909.

Shell elongate, solid, of about seven whorls; whorls gently convex up to a narrow, sunken tabulation; sculpture of eight to eleven prominent, moderately sharp, nearly vertical axial ribs, which are a little swollen and incurved at the tabulation, and a few faint, almost obsolete spiral lines; columella slender, curved, with two thin, sharp, prominent plaits, more or less glazed by a layer of enamel; anterior canal long, curved; no umbilicus visible.
Dimensions: Height, 32 to 38.5 mm.; diameter, 14 to 19 mm.

Type specimen: In the U. S. National Museum, No. 135,050.

Type locality: San Diego well, lower part of Cabrillo Canyon, Balboa Park, San Diego; middle Pliocene.

Pliocene: San Diego well, middle Pliocene; S. D. S. N. H. locality 263, middle Pliocene between Pico Canyon and Fernando Pass, Los Angeles County; loc. 217b, middle Pliocene of Holser Canyon, Los Angeles County (H. R. G.).

This species is quite different from other California species of *Cancellaria;* and although the present writers do not know to what section it should be assigned, they do not believe it belongs to *Narona*. *C. hemphilli* is similar to *Cancellaria thomasiana* Crosse from the China seas. The specimen illustrated on plate 27, figure 3, seemes hardly separable specifically from the Chinese species. So far as known, *C. hemphilli* occurs only in the San Diego horizon of the Pliocene.

Cancellaria arnoldi Dall

Cancellaria arnoldi Dall, U. S. Geol. Surv., Prof. Paper 59, p. 29, pl. 14, fig. 7, 1909.

Type specimen: In the U. S. National Museum, No. 135,038.

Type locality: San Diego well, San Diego, California; Pliocene.

Pliocene: San Diego well (Dall).

Cancellaria arnoldi recalls *C. tritonidea* variety *fernandoensis* Arnold but has a more prominent siphonal fasciole and an open umbilicus. Dall placed this species in the section

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[1] Trans. Conn. Acad. Arts and Sci., Vol. 2, pt. 1, p. 191, pl. 6, fig. 10, 1871.

Merica H. and A. Adams, although it could as well be placed in several other supposed subdivisions. The open umbilicus does not seem to warrant removing it sectionally from other Pliocene species that lack this one character but are like it in others. It does not have the widely open and deeply perforate umbilicus nor the fantastic tabulation of *Trigona pellucida* Perry (= *Cancellaria trigonostoma* Lamarck), the monotype of *Trigona* Perry.[1]

Genus ADMETE Kröyer in Möller, 1842

Admete Kröyer, Möller, Index Moll. Groenl., p. 15, 1842.

Type (by monotypy), *Admete crispa* Möller, a minor variety of *Cancellaria couthouyi* Jay.

Shell thin, rather small, with very weak plaits on the columella.

Admete couthouyi (Jay)

Not *Tritonium viridulum* Fabricius, Fauna Groenl., p. 402, 1780, the type of *Lora*, see *Lora*.

Cancellaria buccinoides Couthouy, Boston Journ. Nat. Hist., Vol. 2, p. 105, pl. 3, fig. 3, 1838, not of Sowerby, 1832.

Cancellaria couthouyi Jay, Cat. Shells, p. 77, 1839; de Kay, Zool., New York, p. 138, pl. 7, fig. 160, 1843; Sowerby, Thes. Conch., Vol. 2, p. 449, pl. 96, figs. 100, 101, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 18, fig. 86, 1856.

? *Admete crispa* Möller, Ind. Moll. Groenl., p. 15, 1842.

? *Cancellaria subangulosa* Wood, Crag Mollusca, Vol. 1, p. 66, pl. 7, figs. 20*a*, 20*b*, 20*aa*, 20*bb*, 1848.

Cancellaria "viridula Fabricius," Sowerby, Thes. Conch., Vol. 2, p. 449, pl. 96, fig. 102, 1849; Reeve, Conch. Icon., Vol. 10, *Cancellaria*, pl. 18, fig. 85, 1856.

Admete "viridula Fabricius," Middendorff "Beitr. Malac. Ross.," Mém. Acad. Imp. Sci. St.-Pétersbourg, Ser. 6, Vol. 6, Pt. 2, pl. 9, figs. 13, 14, 1849, *fide* Dall, 1884; Chenu, Man. Conchyl., Vol. 1, p. 278, text figure, 1853; Dautzenberg and Fischer, Rés. Camp. Sci. Albert I, Prince de Monaco, Fasc. 37, pp. 55-59, 1912.

? *Admete middendorffiana* Dall, Proc. U. S. Nat. Mus., Vol. 7, p. 524, 1884; Vol. 24, p. 516, pl. 38, fig. 6, 1902; U. S. Nat. Mus., Bull. 112, p. 84, 1921.

"*Admete gracilior* Carpenter," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 219, pl. 7, fig. 4, 1903, not of Carpenter.

Admete couthouyi Jay, Dall, U. S. Nat. Mus., Bull. 112, p. 84, pl. 16, fig. 7, 1921.

Admete couthouyi "gracilior Carpenter," Dall, U. S. Nat. Mus. Bull. 112, p. 84, 1921.

Pliocene: Bath-house Beach, Santa Barbara (Arnold); Pliocene of England; etc.

Pleistocene: Lower San Pedro series at Deadman Island, Los Angeles County; Port Los Angeles, near Santa Monica (Arnold; Dall; as *gracilior*); etc.

Recent: Circumboreal; Arctic Sea to San Diego, California.

This variable species has a number of synonyms not included above. It is a matter of personal opinion which named forms can be reasonably considered valid varieties. The form *middendorffiana* Dall, is a low-spired variation; typical *couthouyi* is characterized by small axial plications; *Admete californica* Dall may be another variety; even *modesta* may not be specifically distinct; and the status of *rhyssa* is problematical.

Admete modesta (Carpenter)

Plate 27, Figure 5

Cancellaria modesta Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 32, January, 1865; Newcombe, Nautilus Vol. 10, p. 18, 1896.

Cancellaria (Sveltia) modesta Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 84, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 154, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Neah Bay, Washington.

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[1] Conchology, expl. to pl. 51, figs. 1, 2, January 1, 1811, not *Trigona* Megerle von Mühlfeld, 1811. *Trigonostoma* Blainville, 1826, is a synonym.

Pliocene: S. D. S. N. H. loc. 218, upper Pliocene, Santa Barbara zone, in Sulphur Canyon east of South Mountain, Ventura County (H. R. G.).
Recent: Aleutian Islands, Alaska, to Neah Bay, Puget Sound (Dall).

The specimen figured is less tabulate than those commonly classified as this species. *Cancellaria unalaskensis* Dall may prove to be the young. The true *gracilior* Carpenter in Gabb is probably a variety of *modesta*.

Admete rhyssa Dall

Admete rhyssa Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 306, 1919; U. S. Nat. Mus., Bull. 112, p. 84, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. I, Pt. 1, p. 156, 1927.

Type specimen: In the U. S. National Museum, No. 211,241.

Type locality: U. S. Bureau of Fisheries station 4343, off South Coronado Island, Lower California, Mexico (just south of San Diego, California).

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, "one specimen" (T. S. Oldroyd).
Recent: Santa Rosa Island, California, to South Coronado Island, Mexico (Dall).

This species is as yet unfigured. If the genus were carefully monographed it is likely that a considerable number of species would be reduced to varietal standing or synonymy.

Pleurotoma (*Clathurella*) *dumblei* Anderson,[1] from the middle Miocene beds of Kern River, might be an *Admete;* but it probably is not.

Superfamily Rhachiglossa

Family OLIVIDAE

Genus OLIVA Martyn, 1786

Oliva Martyn, Univ. Conch., Vol. 3, explanatory table and pl. 111, 1786; Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 70, 1799; only example, *Voluta oliva* Linnæus; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 73, 1883; Dall, Proc. U. S. Nat. Mus., Vol. 29, p. 428, October, 1905; Woodring, Carnegie Inst., Publ. No. 385, 1928.

Type (by subsequent designation, Dall, 1905), *Oliva corticata* Martyn, 1786, "Coasts of Guinea" (?), = ? *O. incrassata* Solander (*O. angulata* Lamarck, *fide* Dillwyn, Descript. Cat. Rec. Shells, Vol. 1, p. 516, 1817), figured as *O. angulata* Lamarck by Tryon, Man. Conch., Ser. 1, Vol. 5, pl. 29, fig. 84, 1883.

Shell ovate-cylindrical, smooth, polished, spire low, suture channeled; aperture long, narrow, emarginate anteriorly, channeled posteriorly; outer lip sometimes thickened, parietal wall covered with callus, marked by fine plaits; operculum and epidermis lacking.

Oliva is distinguished from *Olivella* by its larger average size, lower spire, more elongate aperture, and lack of operculum. Woodring has discussed the genotype in the reference given above. Most of the species of *Oliva* are confined to the tropics or warm temperate seas.

Oliva corticata Martyn

Oliva corticata Martyn, Univ. Conch., Vol. 3, pl. 111, left figure, and explanatory table, 1786; Dillwyn, Descript. Cat. Rec. Shells, Vol. 1, p. 516, 1817, in part.

Type locality: Probably west coast of Mexico, Central America, or Panama region, stated to be "Coast of Guinea," probably in error (see discussion below).

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[1] Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 204, pl. 15, figs. 60, 61, 1905; see *Phos dumbleanus* Anderson in Hanna.

A careful comparison of Martyn's colored figure of *Oliva corticata* with Recent specimens labeled "*O. angulata* Lamarck" from the west Mexican coast leads to the opinion that the two represent the same species. There is considerable variation in the size and prominence of the spire and also, to a lesser degree, in the general shape and apertural characters of the Mexican specimens of *angulata*. Many of the older authors made serious errors in locality and it is not improbable that Martyn's shell came from the tropical west American coast instead of the west African. On the other hand, many species of the Panama region are strikingly similar to west African species, and *corticata* may fall in that group of close analogues. Specimens of *Oliva incrassata* Solander (+ *O. angulata* Lamarck) are generally figured as having a heavier lip and callus and a more angulated shoulder than that shown in Martyn's figure of *corticata,* and it is here proposed to use *incrassata* in a varietal sense for the latter form.

Oliva corticata Martyn variety **incrassata** (Solander)

Voluta incrassata Solander, Portland Catalogue, p. 171, 1786, *fide* Johnson, 1911.

Oliva angulata Lamarck, Ann. Mus. Hist. Nat. Paris, Vol. 16, p. 310, 1811; Reeve, Conch. Icon., Vol. 6, *Oliva*, pl. 1, figs. 1*a*, 1*b*, 1850; Marrat, in Sowerby, Thes. Conch., Vol. 4, *Oliva*, p. 3, pl. 1, figs. 7, 8, 1870, "Mazatlan; Gulf of Nicoya;" Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 210, 1909.

Oliva incrassata Solander, Johnson, Nautilus, Vol. 24, p. 122, 1911; Dall, Vol. 22, p. 23, 1918.

Oliva angulata Linnæus, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 149, 151, 1924.

Pleistocene: Magdalena Bay, Lower California, Mexico, lower Pleistocene (Dall, 1918; Jordan, 1924, as *angulata*); upper Pleistocene, coast of Oaxaca, Mexico (coll. by R. H. Palmer).

Recent: Magdalena Bay, Lower California, Mexico, to Peru (Dall, 1909).

This variety differs from the typical form in the shorter, broader shape, more prominent shoulder, heavier outer lip, and thicker callus on the parietal wall near the posterior emargination. Typical *O. corticata,* as illustrated by Martyn, has a less robust, more graceful shell. Specimens from the Gulf of California agree perfectly with Martyn's figure.

Oliva spicata (Bolten)

Porphyria spicata Bolten, Mus. Boltenianum, p. 35, 1798.

Porphyria arachnoidea Bolten, *op. cit.*, p. 36, 1798.

Oliva arenosa Lamarck, Ann. Mus. Hist. Nat. Paris, Vol. 16, p. 315, 1810, in part; Tryon, Man. Conch., Ser. 1, Vol. 5, pl. 27, fig. 62, 1883, *fide* Vanatta.

Oliva reticulata Lamarck, Reeve, Conch. Icon., Vol. 6, *Oliva*, pl. 27, in part, 1850.

Oliva spicata Bolten, Johnson, Nautilus, Vol. 24, p. 121, 1911; Vanatta, Vol. 29, p. 70, 1915; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 452, pl. 21, figs. 4, 5, 1926; Hanna and Hertlein, Vol. 16, p. 143, 1927.

Pliocene: Coyote Mountain, Imperial County (Hanna); Santa Antonita Point, Coronados Island, Carmen Island, and Las Galeras Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Near Las Bolsas Mines, Santa Rosalia, Lower California, Mexico (coll. by M. E. Touwaide); upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).

Recent: Point Abreojos, Lower California, Mexico, to Guayaquil, Ecuador.

This variable species usually has a higher spire than *O. corticata* variety *incrassata* and a smaller callus deposit on the body whorl near the suture. There are several named varieties. In the collections at Stanford University there are deformed specimens from San Ignacio Lagoon, Lower California, that have strong axial folds. These specimens measure only about 40 mm. in length.

Oliva testacea Lamarck

Oliva testacea Lamarck, Ann. Mus. Hist. Nat. Paris, Vol. 16, p. 324, 1810; Lamarck, Hist. Nat. Anim. s. Vert., Desh. & M. Edw. Ed., Vol. 10, p. 627, 1844; Reeve, Conch. Icon., Vol. 6, *Oliva*, pl. 18, fig. 36, 1850; Marrat, in Sowerby, Thes. Conch., Vol. 4, *Oliva*, p. 26, pl. 21, figs. 334, 335, 1870; Tryon, Man. Conch., Ser. 1, Vol. 5, pl. 36, fig. 65, 1883; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 210, 1909.

Type locality: "Habite la mer du Sud, sur les côtes du Mexique."

Pleistocene: Coast of Oaxaca, Mexico (coll. by Palmer).
Recent: Mazatlan, Mexico, to Cobija, Chile (Dall, 1909).

This species has a wide aperture, flaring anteriorly, but not extending as high on the body whorl as in the preceding species. It resembles an *Olivella*. The west African *O. hiatula* Gmelin is very similar, but from the data on hand appears to have on the average a lower spire. Tryon considered them identical.

Genus OLIVELLA Swainson, 1831

Olivella Swainson, Zool. Illustr., Ser. 2, Vol. 2, Expl. pl. 58 (*Oliva*, pl. 2), 1831; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 63, 1883; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 31, 1909; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 229, 1928.

Type (by subsequent designation, Dall, 1909), *Oliva purpurata* Swainson, = *O. dama* (Wood), figured by Sowerby, Thes. Conch., Vol. 4, pl. 349, figs. 368, 369, 1870; Pacific coast of Mexico, Recent.

The genus *Olivella* can be distinguished from *Oliva* by the smaller size of the shells, the more produced spire, and the presence of a horny operculum. The species of *Olivella* venture into cooler waters than do those of *Oliva*, which are essentially tropical in distribution.

Olivella biplicata (Sowerby)

Plate 24, Figure 15

Oliva biplicata Sowerby, Cat. Shells Tankerville, Appen., p. 33, 1825; Reeve, Conch. Icon., Vol. 6, *Oliva*, pl. 20, fig. 48, 1850.

Olivella biplicata Sowerby, Swainson, Treat. Malac., p. 82 ("*Olivilla*" by mistake), pp. 133, 322, text fig. 3, 1840; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 255, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 219, 1903; Keep, West American Shells, Rev. Ed., p. 138, text fig. 112, 1911; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 85, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 160, pl. 26, figs. 20, 20*a*, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 252, 254, 1929.

Oliva (Callianax) biplicata Sowerby, Tryon, Man. Conch., Ser. 1, Vol. 5, p. 87, pl. 34, fig. 58, 1883.

Olivella biplicata lapillus Vanatta, Nautilus, Vol. 29, p. 71, October, 1915; Dall, U. S. Nat. Mus., Bull. 112, p. 85, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 161, 1927.

Olivella biplicata angelena T. S. Oldroyd, Nautilus, Vol. 32, p. 34, July, 1918.

Olivella biplicata fucana T. S. Oldroyd, Nautilus, Vol. 34, p. 118, pl. 5, fig. 4, April, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 161, pl. 26, figs. 23, 23*a*, 1927.

Olivella biplicata parva T. S. Oldroyd, Nautilus, Vol. 34, p. 119, pl. 5, fig. 7, 1921; I. S. Oldroyd, *op. cit.*, p. 162, pl. 26, figs. 16, 16*a*, 1927.

Olivella biplicata angelina Oldroyd, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 161, pl. 26, figs. 17, 17*a*, 1927 (*err. pro angelena*).

Type specimens: Of *biplicata*, unknown to authors; of *lapillus*, in the Academy of Natural Sciences of Philadelphia, No. 111,977; of *angelena*, *fucana*, and *parva*, in the Oldroyd Collection, Stanford University.

Type localities: Of *biplicata*, "West coast of North America"; of *lapillus*, San Pedro; of *angelena*, San Pedro, Pleistocene; of *fucana*, Straits of Juan de Fuca; of *parva*, Point Abreojos, Lower California, Mexico.

Pliocene: Twelve Mile House, Seven Mile House, San Mateo County; San Diego well, San Diego (Cooper); common in *Pecten coalingensis* zone of the lower Etchegoin of the Coalinga region; lower Merced and upper Sargent of middle California (Nomland, 1917); "Pico" near Ventura (Waterfall); etc.
Pleistocene: "Pliocene" of San Pedro region (Arnold); common in lower and upper San Pedro beds (Arnold; T. S. Oldroyd, also as variety *angelena*); Point Firmin, Los Angeles (Chace); Santa Monica palisades (F. C. Clark collection); Pleistocene of Ventura (Arnold); Pacific Beach and foot of Twenty-sixth Street, San Diego (Stephens); upper Pleistocene, Campbell Ranch, near Goleta, Santa Barbara County (U. S. G.); lower Quaternary of Magdalena Bay and upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan); etc.
Recent: British Columbia to Lower California, Mexico.

This is a rather stout, heavy-shelled species, with from one to four plicæ on the base of the columella, above which there appears to be an excavation. It is common in many Pleistocene localities in southern California. It is heavier, larger, and less elongate than *bœtica*.

It is not probable that the strains of the various named minor variants could keep pure in view of their known ranges.

Olivella dama (Wood)

Voluta dama Wood, Index Test., Suppl., p. 11 and figure, 1828.
Oliva dama Mawe, Tryon, Man. Conch., Ser. 1, Vol. 5, p. 71, pl. 17, fig. 39, 1883.
Olivella dama Mawe, Dall, Nautilus, Vol. 32, p. 23, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Pleistocene: Magdalena Bay (Dall; Jordan); upper Quaternary at San Ignacio Lagoon (Jordan), both in Lower California, Mexico.
Recent: Gulf of California to Mazatlan, Mexico.

Olivella pedroana (Conrad)

Plate 24, Figure 10

Strephona pedroana Conrad, U. S. House of Representatives, House Document 129, p. 17, 1855; U. S. Pacific R. R. Repts., Vol. 5, p. 327, pl. 6, fig. 51, 1856.
Olivella intorta Carpenter, Proc. Zool. Soc. London for 1856, p. 207, Jan. 7, 1857; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 255, 1888; Keep, West Coast Shells, p. 42, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 212, pl. 19, fig. 9, 1892; Arnold, Mem. Calif. Acad. Sci., Vol., 3, p. 220, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914; Martin, Vol. 9, p. 257, 1916; Moody, Vol. 10, p. 24, 1916.
Olivella pedroana Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 221, but not all the synonymy, 1903; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 32, pl. 6, fig. 1, 1909; Weaver, Wash. Geol. Surv., Bull. 15, p. 22, 1912; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 591, 594, 597, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 423, pl. 69, fig. 3, 1915; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, pp. 30, 32, 1916; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 423, 1915; Martin, Vol. 9, p. 257, 1916; Nomland, Vol. 10, p. 221, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 85, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 162, 1927; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 251, 254, 1929.

Type locality: Of *pedroana*, San Pedro, California, Recent.

Miocene: Temblor formation, lower middle Miocene (Clark; Anderson and Martin); Montesano formation, middle Miocene of western Washington (Weaver); upper and lower San Pablo formation, middle California (Clark); Empire formation, Coos Bay, Oregon (Dall; Arnold and Hannibal; Howe); etc.
Pliocene: Jacalitos, Etchegoin, Merced, Purisima, upper Sargent, etc., of middle California and Coalinga region (Arnold and Hannibal; Martin; Nomland; etc.); San Diego well (Dall); lower Pliocene of Elsmere Canyon, Los Angeles County (Arnold, 1907); lower Pliocene of Holser Canyon, Los Angeles County (English); etc.

Pleistocene: Lower and upper San Pedro series of San Pedro region; Barlow's Ranch, near Ventura; foot of Twenty-sixth Street, San Diego (Arnold); Santa Barbara to San Diego (Cooper); near International Boundary Monument No. 258; Pacific Beach (Stephens); upper Pleistocene of San Quintin Bay and of San Ignacio Lagoon, Lower California, Mexico (Jordan, 1924, 1926); etc.

Recent: Puget Sound to Cape San Lucas, Lower California, Mexico (Dall, 1921).

This species has often been reported in the Pliocene and Pleistocene formations of California, but the Recent shell is not so common in collections as might be expected. It is very similar to *bætica* Carpenter, and the southern part of the living range may refer to the latter form.

Olivella bætica Carpenter

Olivella bætica Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 75, 1868-9; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 71, pl. 17, figs. 28, 29, 1883; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 255, 1888.

Olivella boetica Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 85, pl. 15, fig. 1, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 163, pl. 26, figs. 19, 19*a*, 22, 22*a*, 1917; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 250, 252, 1929.

Olivella boetica diegensis T. S. Oldroyd, Nautilus, Vol. 34, p. 118, pl. 5, fig. 2, April, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 163, pl. 26, figs. 18, 18a, 1927.

Olivella boetica mexicana T. S. Oldroyd, Nautilus, Vol. 34, p. 118, pl. 5, fig. 3, April, 1921; I. S. Oldroyd, *op. cit.*, p. 163, pl. 26, figs. 21, 21*a*, 1927.

Pliocene: Seven Mile Beach and Twelve Mile House, San Mateo County; San Diego well (Cooper).

Pleistocene: Santa Barbara to San Diego (Cooper); lower San Pedro of Nob Hill cut, San Pedro (T. S. Oldroyd); upper San Pedro horizon at San Pedro (T. S. Oldroyd, as var. *mexicana* and var. *diegensis*); Spanish Bight and near beach at Mexican boundary (Stephens); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Kodiak Island, Alaska, to Cape San Lucas, Lower California, Mexico (Dall, 1921).

This species is more slender than *biplicata*. It appears to be larger in the northern part of its range. It may be only a variety of *pedroana*.

Olivella bætica Carpenter variety **porteri** Dall

Olivella (*anazora* Duel. var. ?) *porteri* Dall, Nautilus, Vol. 23, p. 133, April, 1910.

Olivella porteri Dall, U. S. Nat. Mus., Bull. 112, p. 85, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 162, 1927.

Type specimen: In the U. S. National Museum, No. 209,677.

Type locality: San Diego, California, Recent.

Pleistocene: Lower Quaternary at Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Redondo, Los Angeles County, California, to Magdalena Bay, Lower California, Mexico (Dall, 1921).

This is a slender form, often of a bluish-gray color with cloudings of liver color sometimes in zig-zag lines. It is probably a deeper water variety or variation of *bætica*.

Olivella gracilis (Broderip and Sowerby)

Oliva gracilis Broderip and Sowerby, Zool. Journ., Vol. 4, p. 379, January, 1829; Reeve, Conch. Icon., Vol. 6, *Oliva*, pl. 20, fig. 46, 1850; not *Oliva gracilis* Lea, Contr. Geol., p. 182, pl. 6, fig. 196, 1833.

Olivella gracilis Broderip and Sowerby, Tryon, Man. Conch., Ser. 1, Vol. 5, p. 70, pl. 16, fig. 26, 1883; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 453, 1926.

Pliocene: Coyote Mountain, Imperial County (Hanna).

Pleistocene: Coast of Oaxaca, Mexico (collected by R. H. Palmer).

Recent: Gulf of California to Mazatlan, Mexico.

This is an elongate species, the whorls steeply descending so that even the penultimate whorl is quite long. Tryon suggests that *O. tenuis* (Marrat)[1] may have been based on a juvenile specimen of *gracilis*.

Olivella inconspicua (C. B. Adams)

Oliva inconspicua C. B. Adams, Ann. Lyceum Nat. Hist. New York, Vol. 5, p. 50 of the separate, 1852.
Olivella inconspicua C. B. Adams, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924.

Pleistocene: Upper Quaternary at San Ignacio Lagoon, Lower California, Mexico (Jordan).
Recent: Gulf of California, Mexico, to Panama (Jordan).

Family MARGINELLIDAE

This family comprises a group of glossy-shelled species characterized chiefly by the presence of plications on the columella. The typical genus includes species with *Voluta*-like shells; but this type is connected by representatives of almost every intermediate stage to an extreme type with shortened or sunken spire and elongate, crescentic aperture, the posterior portion of which ascends to the apex of the shell. Some species belonging to the latter group are minute in size. *Marginella, s. s.*, is distinguished from *Voluta* by its smaller size, by its usually thickened and frequently denticulate outer lip, and by the absence of the deep notch in the anterior canal.

The *Marginellidæ* are tropical and subtropical, few species venturing into temperate regions. The family dates back at least as far as the lower Eocene and is well represented in the European Tertiary. A number of species occur in the early and middle Tertiary of the western Atlantic coast and the West Indian regions, but the Tertiary of western North America has yielded only one or two species. The earliest definitely recognizable species of the *Marginellidæ* reported from the Pacific coast is "*Marginella*" *pacifica* Dickerson, not Pease, which has been renamed *instabilata* by Hanna and is a *Hyalina*, probably of the *Cystiscus* group. It is thought to be Oligocene in age. No species of *Marginella, s. s.*, has been definitely reported from California, either fossil or Recent.

In order to determine the generic positions of the Pacific coast *Marginellidæ*, it was necessary to consider the various names that have been commonly used for the different genera and minor divisions. The arrangement resulting from this brief review is outlined below:

Genus *Marginella* Lamarck, 1799, type *Voluta glabella* Linnæus.
    (+ *Marginellarius* Duméril, 1806; *Marginellus* Montfort, 1810; *Phænospira* Hinds, 1844; *Porcellana* Gray, 1857, not *Porcellana* Martini, Conch. Cab., Vol. 1, p. 326, 1769 = *Cypræa* Linnæus; *Pseudomarginella* Maltzan, 1880, *fide* Cook, Proc. Malac. Soc. London, Vol. 15, pp. 3-5, 1922.)
    Spire elevated, shell typically of large size, outer lip thickened.
  Subgenus *Marginella, s. s.*
    Comparatively high spired, four strong plaits.
  Subgenus *Glabella* Swainson, 1840, type *G. faba* Linnæus.
    (+ *Faba* Fischer, 1883.)
    With axial ribs.
  Subgenus *Prunum* Herrmannsen, 1852, type *M. prunum* Gmelin.
    Lower spire; more elongate, subcylindric shape, deeper sinus.
  Subgenus *Serrata* Jousseaume, 1875, type *M. serrata* Gaskoin.
    Like *Prunum* but small, with thickened, serrated outer lip.
  Subgenus *Eratoidea* Weinkauff, 1880, type *M. margarita* Kiener.
    Small, stout.

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[1] In Sowerby, Thes. Conch., Vol. 4, *Oliva*, p. 32, pl. 22, fig. 385, 1870.

Genus *Persicula* Schumacher, 1817, type *P. variabilis* Schumacher = *V. persicula* Linnæus.
(+ *Gibberula* Swainson, 1840; *Cryptospira* Hinds, 1844.)
Spire very low or sunken; shell usually of large size; outer lip thickened; aperture long, posterior end ascending toward the apex of the shell.
Subgenus *Persicula, s. s.*
Spire not elevated; outer lip arching over toward the apex of the shell.
Subgenus *Bullata* Jousseaume, 1875, type *M. bullata* Born.
(+ *Volutella* Swainson, 1820, not Perry, 1811, nor d'Orbigny; *Egouena* Jousseaume, 1875; *Gibberulina* Monterosato, 1884; ? *Leptegouana* Woodring, 1928.)
Spire low, with callus wash; callus pile on parietal wall.
Subgenus *Closia* Gray, 1857, type *M. sarda* Kiener.
(+ ? *Balanetta* Jousseaume, 1875.)
Spire invisible; outer lip extending to the apex of the shell; plications typically concentrated on the anterior portion of the columella.

Genus *Hyalina* Schumacher, 1817, type *H. pellucida* Schumacher.
(+ *Volvarina* Hinds, 1844; *Granula* Jousseaume, 1875.)
Relatively small, spire low or covered; aperture long; outer lip simple.
Subgenus *Hyalina, s. s.*
Elongate; low spired.
Subgenus *Neovolvaria* Fischer, 1883, type *M. pallida* Linnæus.
Shape cylindric; outer lip flaring anteriorly.
Subgenus *Cystiscus* Stimpson, 1865, type *Cystiscus capensis* Stimpson, 1865, = *Marginella cystiscus* Redfield, 1870 (not *M. capensis* Dunker, 1848).
Smaller, relatively broader.
Subgenus *Cypræolina* Cerulli-Irelli, 1911, type *Cryptospira* (*Cypræolina*) *clandestina* Brocchi, 1814.
(+ *Merovia* Dall, 1921.)
Small; spire covered by posterior part of outer lip; *Closia*-shaped.

The name *Hyalina* Schumacher is used for the very natural group of small, typically elongated shells with a simple outer lip or at least without the great thickening and denticulations that occur on the outer lip of some species belonging to *Marginella* and *Persicula*. The type of *Hyalina* has been said[1] to be indeterminable; but from a study of Martini's figure[2] and description, upon which *H. pellucida* was based, it is quite apparent what group Schumacher intended to name. Martini's figure is fairly good, considering the methods of reproduction available at the time and the small, unimposing character of the subject. Some quite recently published illustrations of supposed new species are less edifying than Martini's figures. *Hyalina californica* (Tomlin) is certainly a typical *Hyalina*. In fact, this species greatly resembles Martini's figure of *pellucida* Schumacher.

Genus HYALINA Schumacher, 1817

Hyalina Schumacher, Ess. Nouv. Syst. Hab. Vers Test., p. 234, 1817; Tomlin, Proc. Malac. Soc. London, Vol. 12, p. 244, 1917.

Type (by monotypy), *H. pellucida* Schumacher.

Shell small; spire low or concealed by a callus wash or by the posterior margin of the aperture; outer lip simple or slightly thickened, without strong denticulations.

Subgenus HYALINA, s. s.

Shell elongate, oval; spire low, small, but clearly visible; columella somewhat constricted.

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[1] Tomlin, Proc. Malac. Soc. London, Vol. 12, p. 288, 1917.

[2] Martini, Conch. Cab., Vol. 2, p. 108, pl. 42, fig. 426, 1773.

Hyalina (Hyalina) californica (Tomlin)

"*Volvarina varia* Sowerby," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Keep, West Coast Shells, p. 43, 1888, 1892; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 176, 1894; and of Pacific coast authors before 1916, not of Sowerby, Proc. Zool. Soc. London for 1846, p. 97, 1846, and Thes. Conch., Vol. 1, p. 390, pl. 76, figs. 137-141, 1846, *fide* Tomlin, Nautilus, Vol. 29, p. 138, April, 1916.

"*Marginella* (*Volvarina*) *varia* Sowerby," Arnold, Mem. Calif. Acad. Sci., Vol. 4, p. 222, pl. 4, fig. 9, 1903.

Marginella (*Hyalina*) *californica* Tomlin, Nautilus, Vol. 29, p. 138, 1916; Dall, Bull. 112, U. S. Nat. Mus., p. 85, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 165, 1927.

Type specimen: In the Tomlin Collection, England.

Type locality: California, Recent.

Pleistocene: All lower and upper San Pedro localities in the vicinity of San Pedro, California; Pleistocene of Twenty-sixth Street, San Diego, California (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan, 1926); Signal Hill (Oldroyd, as *varia* Sby.).

Recent: San Pedro, California, to Puerto Libertad, Mexico (Dall, 1921), and the Galapagos (Stearns).

This is the largest species of the family in the California region. It is recognizable by its size and its small but elevated spire.

Subgenus **CYSTISCUS** Stimpson, 1865

Cystiscus Stimpson, Amer. Journ. Conch., Vol. 1, p. 55, 1865.

Type (by monotypy), *Cystiscus capensis* Stimpson, (= *Marginella cystiscus* Redfield), Amer. Journ. Conch., Vol. 6, p. 2, supplement pp. 226, 230, 1870 (not *M. capensis* Dunker, *ex* Dunker MS., Südafrik. Moll., p. 125, pl. 6, fig. 21, 1848).

Shell small, ovate, aperture hardly reaching spire, which is very low and inconspicuous.

Geologic range: On Pacific coast of North America, Oligocene to Recent.

Distribution: Tropical and warm temperate waters.

This subgenus is a group intermediate between *Hyalina* with a definite spire and *Cypræolina* with the spire concealed by the posterior margin of the elongated aperture. Stimson regarded the type of his genus sufficiently different anatomically to warrant a new family name; but this opinion has not generally been followed by later authors.

Hyalina (Cystiscus) jewettii (Carpenter)

Plate 24, Figure 17

Marginella jewettii Carpenter, Proc. Zool. Soc. London for 1856, p. 207, Jan. 7, 1857; Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 43, pl. 12, fig. 57, 1883; Cooper, Seventh Ann. Rept. Calif. St. Mineralogist, p. 249, 1888; Dall, Trans. Wagner Free Inst. Sci., Vol. 3, pt. 1, p. 57, 1890; Keep, West Coast Shells, p. 43, fig. 23, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 212, pl. 19, fig. 6, 1892; Baker, Nautilus, Vol. 16, p. 40, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 221, 1903; Keep, West American Shells, p. 166, fig. 153, 1904; West American Shells, Rev. Ed., p. 142, fig. 114, 1911; E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 1 (41), 1919; Dall, Bull. 112, U. S. Nat. Mus., p. 85, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; T. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 164, 1927.

Marginella jewettii Carpenter, var. *nanella* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, pp. 11, 24, pl. 2, fig. 8, January 16, 1925.

Type specimens: In the U. S. National Museum.

Type localities: Of *jewettii*, Santa Barbara, California, Recent; of variety *nanella*, Nob Hill cut, San Pedro, California, Pleistocene.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd, as variety *nanella*); upper San Pedro series at Crawfish George's, San Pedro, and Deadman Island (Arnold); Chiton bed at Point Firmin, Los Angeles County (E. P. and E. M. Chace); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to San Martin Island, Lower California, Mexico (Baker).

This species differs from *H. californica* by its ovate or pyriform shape, its smaller size, and very low, inconspicuous spire. Recent specimens are very light gray, almost white. The number of plications on the columella varies from three to as many as eight, the small additional ones being added above the regular ones.

The name *nanella* applies to specimens of *jewettii* which have the more numerous plications on the inner lip. This character, by which *nanella* is distinguished, does not appear to have any systematic significance. The form with the extra plications occurs associated with the more normal form which has four to six plications, and intergrades perfectly with it.

H. subtrigona is similar in general appearance but is smaller.

Hyalina (Cystiscus) subtrigona (Carpenter)

Marginella subtrigona Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 537, 661, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 397, May, 1865; Tryon, Man. Conch., Ser. 1, Vol. 5, pp. 43, 198, pl. 12, fig. 55, 1883; T. S. Oldroyd, Nautilus, Vol. 28, p. 81, 1914; Dall, Bull. 112, U. S. Nat. Mus., p. 85, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22 (No. 2535), p. 11, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 164, 1927.

Type specimen: In the British Museum.

Type locality: Santa Barbara, California.

Pleistocene: Lower San Pedro of Nob Hill cut, San Pedro; upper San Pedro of Signal Hill, Los Angeles County, (T. S. Oldroyd).

Recent: Monterey to San Diego, California (Dall).

This species much resembles *H. jewettii* but is considerably smaller. It has sometimes as many as seven or eight columellar plaits, the posterior ones being very faint. Occasional specimens show a few weak denticulations on the inside of the outer lip, which is exceptional in this genus. *H. regularis* (Carpenter) is smaller, on the average, and is a narrower form.

Hyalina (Cystiscus) regularis (Carpenter)

Marginella regularis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 398, March, 1865; Baker, Nautilus, Vol. 16, p. 40, 1902; Dall, Bull. 112, U. S. Nat. Mus., p. 85, 1921, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 164, 1927.

Similar to *subtrigona* but usually slightly smaller, with fewer, more widely spaced columellar plications and narrower shape. Average length about 2.5 mm.

Type specimen: In the British Museum.

Type locality: Santa Barbara, California.

Pleistocene: San Pedro, California (in Oldroyd Collection at Stanford University); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan).

Recent: Monterey to Gulf of California.

Hyalina (Cystiscus) oldroydæ (E. K. Jordan)

Marginella oldroydæ E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 250, pl. 25, fig. 7, 1926.

Type specimen: At the California Academy of Sciences, No. 1846.

Type locality: San Quintin Bay, Lower California, Mexico; upper Pleistocene.

Pleistocene: At the type locality.

This species or variety is related to *regularis* (Carpenter), but is evenly ovate instead of pyriform, the greatest width occurring just posterior to the middle of the shell. The evenly ovate form is characteristic. The spire does not seem to be glazed over. There are about a dozen specimens in the collection of the California Academy of Sciences, all from the type locality.

Hyalina (Cystiscus) instabilata (Hanna)

Marginella pacifica Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 7, p. 178, pl. 31, fig. 2, 1917, not *M. pacifica* Pease, 1868.

Marginella instabilata Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 170, 1924, new name for *M. pacifica* Dickerson.

Type specimen: At the California Academy of Sciences, San Francisco.

Type locality: Near Vader, Lewis County, Washington; Oligocene.

Oligocene: At the type locality.

The shell characters of this small species place it in *Cystiscus.* There are five oblique plications, including the one on the lower, obliquely-truncated margin of the columella. On the inside of the outer lip there are six small lirations. The suture between the whorls of the low spire is not clearly marked. Dickerson reported the species abundant in the *Molopophorus lincolnensis* zone, Lincoln horizon of the lower Oligocene, at the type locality in Washington.

Subgenus **CYPRAEOLINA** Cerulli-Irelli, 1911

Cypræolina S. Cerrulli-Irelli, Palæontographia Italica, Memorie di Paleontologia, Vol. 17, p. 231, pl. 21, figs. 9-14, 1911, new subgenus of *Cryptospira* Hinds, 1844.

Merovia Dall, Bull. 112, U. S. Nat. Mus., p. 86, 1921, monotype, *Volutella pyriformis* Carpenter, figured by Tryon, Man. Conch., Vol. 5, pl. 12, fig. 65, 1883.

Type (by monotypy), *Cryptospira* (*Cypræolina*) *clandestina* Brocchi.

Shell small, aperture lengthened posteriorly, margin covering the apex of the shell.

Hyalina (Cypraeolina) pyriformis (Carpenter)

Volutella pyriformis Carpenter, Journ. Conchyl., Ser. 3, Vol. 5, p. 148, 1865.

Merovia pyriformis Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 86, 1921.

"*Cypræolina margaritula* Carpenter," T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925.

Marginella pyriformis Carpenter, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Cypræolina pyriformis Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 166, 1927.

Type specimen: In the U. S. National Museum (?).

Type locality: San Diego, California.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan); Pleistocene of San Pedro (T. S. Oldroyd coll.); lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd, as *C. margaritula*).

Recent: Peril Strait, Alaska, to Mazatlan, Mexico (Dall, 1921).

This species is the type of *Merovia* Dall, which is clearly a synonym of *Cypræolina* Cerrulli-Irelli. It is larger and a little less pyriform than *H. clandestina* (Brocchi), the type of *Cypræolina*. It is similar to *H. margaritula* (Carpenter), but that species differs in having a more effuse or dilated anterior portion of the aperture. The specimens at Stanford University identified as *margaritula* by Mr. T. S. Oldroyd are *pyriformis*.

Family VOLUTIDAE

Shell turreted, apex papillary, aperture notched in front; columella obliquely plaited; with or without an operculum, which, when present, has a terminal or subterminal nucleus.

The *Mitridæ* differ in not having a papillary apex and in having the columellar plications heavier posteriorly.

Genus PSEPHAEA Crosse, 1871

Psephæa Crosse, Journ. de Conchyl., Vol. 19 (Ser. 3, Vol. 11), p. 302, October, 1871, only species *Voluta concinna* Broderip; Tryon, Man. Conch., Ser. 1, Vol. 4, p. 98, 1882; Fischer, Man. Conchyl., p. 607, 1883; Cossmann, Ess. Paléo. Comp., Vol. 3, p. 145, 1899.

Miopleiona Dall, Smithsonian Misc. Coll., Vol. 50, Pt. 1, p. 11, March 7, 1907; U. S. Geol. Surv., Prof. Paper 59, p. 35, April 2, 1909.

Type (by monotypy), *Voluta concinna* Broderip, Proc. Zool. Soc. London, Pt. 4, p. 43, 1836; figured by Reeve, Conch. Icon., Vol. 6, *Voluta*, pl. 21, fig. 53, 1849; also figured by Crosse, *op. cit.*, pl. 12, fig. 7, 1871; Japan, Recent.

Shell elongate, spire produced; sculpture consisting of axial folds, which may be accentuated toward the upper part of the whorl in such a way as to produce a shouldered effect, also of very fine growth lines; aperture large, elongate; outer lip sometimes a little thickened and slightly flaring, inner lip with a wide, thin callus deposit; columella tapering, with two subdued, very oblique plications.

Geologic range: Eocene to Recent.

Distribution: Warm and temperate waters.

Miopleiona Dall[1] differs so little from *Psephæa* Crosse that the former must be considered a synonym. *Psephæa* appears to be generically distinct from *Voluta* Linnæus, having a much higher spire and two columellar plications, one of moderate size and one small, instead of four.

Psephæa prevostiana (Crosse)

Plate 27, Figure 9

? "*Voluta lyriformis* Vigors," Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 3, "Volute," p. 35, pl. 42, fig. 2, 1839; ? not "*Mitra*" *lyriformis* Swainson, Zool. Illust., Vol. 1, pl. 54, 1821.

Voluta prevostiana Crosse, Journ. Conchyl., Ser. 3, Vol. 18, p. 165, 1878; Vol. 19, p. 41, pl. 1, pl. 2, fig. 1, 1879; Vol. 27, p. 42, pl. 1, 1887; Sowerby, Ann. Mag. Nat. Hist., Ser. 8, Vol. 14, p. 81, 1914.

"*Voluta megaspira* Sowerby," Tryon, Man. Conch., Vol. 4, p. 95, in part only, pl. 30, fig. 132, 1882, not of Sowerby, Thes. Conch., Vol. 1, p. 208, pl. 48, figs. 31, 32, 1844, nor of Yokoyama, Journ. Faculty Sci., Imper. Univ. Tokyo, Sect. 2, Vol. 1, p. 316, 1926.

Voluta megaspira, var. *prevostiana* Crosse, Sowerby, Thes. Conch., Vol. 5, p. 298, pl. 573, fig. 144, 1887.

Type locality: Japan.

Recent: Japanese region.

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[1] Dall designated *M. indurata* (Conrad) as type.

This high-spired, rather thin-shelled species lacks the shoulders on the axial ribs which are present on *P. concinna,* the genotype of *Psephœa,* but it is closely related. A comparison of specimens of typical *prevostiana* from the Japanese region with fossil specimens of the variety *oregonensis* (Dall) shows that the only difference is that the fossil variety has somewhat fewer and slightly protractively sloping axial ribs. The Recent typical variety and the fossil variety are figured side by side on plate 27. In the collection at Stanford University there is a large Recent specimen of typical *prevostiana* from Japan which measures 140 mm. in length and 72 mm. in width.

Psephæa prevostiana (Crosse) variety **oregonensis** (Dall)

Plate 27, Figures 6, 10

"*Rostellaria indurata* Conrad," in part, of authors prior to 1907.

Miopleiona oregonensis Dall, Smithsonian Misc. Coll., Vol. 50, Pt. 1, p. 11, March 7, 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 34, pl. 37, fig. 2, 1908; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 35, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913; J. P. Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, p. 143, 1919; Howe, Univ. Calif. Publ. Geol., Vol. 14, table opp. p. 93, 1922.

Type specimen: In the U. S. National Museum, No. 153,894.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Empire formation, upper Miocene of Coos Bay, Oregon (Dall, 1909; also reported from "Tillamook Head, Washington," which may be an error).

Pliocene: Coos conglomerate, Coos Bay, Oregon (Howe); Wildcat formation of Humboldt County (J. P. Smith); Eel River beds, northern California (coll. by Harold Hannibal); Pliocene of Año Nuevo Point, San Mateo County (coll. by R. Arnold); about 12 miles south of Gary, Santa Barbara County (Arnold); "Fernando" of Fugler's Point, Santa Barbara County (Carson); San Diego (coll. Los Angeles Museum).

This variety differs from the typical form only in the slope of the axial ribs, which are perhaps fewer in number. *P. indurata* (Conrad), the Oligocene and Miocene species, is specifically distinct. H. G. Schenck states that there is another, as yet undescribed, species in the Oregonian Oligocene.

Family MITRIDAE

Shell elongate, spire produced, with an acute apex; columella with plications that are stronger posteriorly.

Genus MITRA Martyn, 1784

Mitra Martyn, Univ. Conch., Vol. 1, explanatory table and pl. 19, 1784; Dall, Proc. U. S. Nat. Mus., Vol. 29, p. 428, 1905; Woodring, Carnegie Inst., Publ. No. 385, p. 242, 1928.

Type (by subsequent designation, Dall, 1905), *Mitra tessellata* Martyn, *op. cit.,* pl. 19, 1784; figured also by Reeve, Conch. Icon., Vol. 2, *Mitra,* pl. 2, fig. 10, 1844; also by Tryon, Man. Conch., Ser. 1, Vol. 4, p. 132, pl. 38, fig. 139, 1882; China, Recent.

In the Tenth Edition of the Systema Naturæ (p. 732), Linnæus appears to have used *Mitra* as a subgenus of *Voluta* with the species *episcopalis* and *papalis,* but the inconsistencies in Linnæus' treatment of such minor subdivisions have led authors to disregard his minor group names. If the Linnæan *Mitra* is used, the type is *M. episcopalis* Linnæus, as that species was cited by Children[1] in 1823.

The type of *Mitra* Martyn is a high-spired form having axial and spiral sculpture in a cancellated pattern, which sometimes appears like regularly arranged pits or punctations. The species catalogued below, while not typical, are not subgenerically different from *Mitra, s. s.* They do not seem to be closer to the subgenus *Strigatella* than to *Mitra, s. s.* The type of *Strigatella* is *Mitra zebra* Lamarck, a smooth, rather short species much like a *Pyrene*. *Strigatella* should not be used in more than a subgeneric sense, for while some of the short, pyreniform, thick-lipped species belonging clearly to *Strigatella* are very different from *Mitra, s. s.*, there are several intermediate species, and there is no natural break between the two.

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[1] Quarterly Journ. Sci., Lit., and the Arts, p. 62, October, 1823.

Mitra idæ Melvill

"*Mitra maura* Swainson," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Tryon, Man. Conch., Ser. 1, Vol. 4, p. 121, in part, not pl. 36, fig. 67, 1882; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 257, 1888; Keep, West Coast Shells, p. 42, fig. 22, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 222, 1903; not *Mitra maura* (Swainson, MS.) Broderip, Proc. Zool. Soc. London, Pt. 3, p. 193, April, 1836, = *M. orientalis* Gray, 1834.

Mitra idæ Melvill, The Conchologist, Vol. 2, p. 140, pl. 1, fig. 6, June 24, 1893; Williamson, Proc. Biol. Soc. Washington, Vol. 19, p. 195, figs. 1-5, 1906; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 170, 1927.

Mitra idæ "Dall," English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914.

Strigatella (Atrimitra) idæ Melvill, Dall, U. S. Nat. Mus., Bull. 112, p. 86, 1921.

Type specimen: In the collection of Sir J. R. LeB. Tomlin, St. Leonards-on-Sea, England.

Type locality: Point Loma, San Diego County, California; Recent.

Pliocene: Lower Pliocene of Elsmere Canyon, Los Angeles County (English); lower part of the upper Pliocene at Fifth and Hope Streets, Los Angeles, California.

Pleistocene: Lower San Pedro series at San Pedro and upper San Pedro series at Deadman Island, San Pedro, and Crawfish George's, Los Angeles County (Arnold); upper Pleistocene of San Diego (in the Oldroyd Collection at Stanford University).

Recent: Farallone Islands to San Diego and Cortez Bank, California.

This species is the North American analogue of the Peruvian *Mitra orientalis* Gray[1] (+ *M. maura* Swainson MS., Broderip). It is smaller and the whorls are less ventricose than the southern species. *M. fultoni* E. A. Smith has a more attenuated spire and the spiral punctation is more distant, deeper, and wider.

Mitra idæ Melvill variety **montereyi** Berry

Mitra montereyi Berry, Proc. Malac. Soc. London, Vol. 14, p. 31, text figures 1-4, 1920.

Strigatella (Atrimitra) idæ montereyensis Berry, Dall, U. S. Nat. Mus., Bull. 112, p. 86, 1921.

Mitra idæ montereyensis Berry, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 171, 1927.

Strigatella (Atrimitra) idea montereyensis Berry, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: In the collection of S. S. Berry, Redlands, California.

Type locality: Twelve fathoms off Del Monte, Monterey Bay, California.

Pliocene: "Lower Pico," middle Pliocene near Ventura (Waterfall).
Recent: Monterey to San Diego, California (Dall).

This form is very similar to the typical form of *idæ* but is larger and more robust. The lower Pliocene record of *idæ* (Elsmere Canyon, *fide* English) may refer to this variety.

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[1] In Griffith's Cuvier, pl. 40, fig. 5, 1834.

Mitra fultoni E. A. Smith

Mitra fultoni E. A. Smith, Ann. Mag. Nat. Hist., Ser. 6, Vol. 9, p. 256, text figure, 1892; Williamson, Bull. So. Calif. Acad. Sci., Vol. 4, p. 123, 1905; Proc. Biol. Soc. Washington, Vol. 19, p. 197, text fig. 6, 1906.

Type locality: Point Abreojos, Lower California, Mexico; Recent.

Pleistocene: Upper Pleistocene near Santa Monica (in the Oldroyd Collection at Stanford University).
Recent: Lower California, Mexico, southward.

This species is rather slender for the *orientalis* group and can be distinguished by a slight shoulder on the whorls and some minor differences in sculpture.

Mitra catalinæ (Dall)

Plate 28, Figure 4

Strigatella (*Atrimitra*) *catalinæ* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 308, August 30, 1919; U. S. Nat. Mus., Bull. 112, p. 86, 1921.
Strigatella catalinæ Dall, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.
Mitra catalinæ Dall, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 169, 1927.

Type specimen: In the U. S. National Museum, No. 219,648.

Type locality: San Pedro, California; Recent.

Pliocene: S. D. S. N. H. locality 217b, middle Pliocene of Holser Canyon, Los Angeles County (H. R. G.).
Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Crescent City to San Diego, California (Dall, 1921).

The general appearance of the shell of this species suggests that it may be the young of *Mitra idæ* Melvill, but there are not sufficient specimens on hand to decide the matter.

Section Tiara Swainson, 1831

Tiara Swainson, Zool. Illustr., Ser. 2, Vol. 2, expl. pl. 50 (*Mitrinæ*, pl. 5), 1831; Woodring, Carnegie Inst., Publ. No. 385, p. 242, 1928; not *Thiara* Bolten, Mus. Boltenianum, p. 190, 1798, misspelled "*Tiara*" by Herrmannsen, Ind. Gen. Malac., Vol. 2, p. 576, 1849; not *Thiara* Menke, Syn. Meth. Moll., Ed. 2, p. 42, 1830, misspelled "*Tiara*" by Agassiz, Nomen. Zool., Moll., p. 90, 1846.
Cancilla Swainson, Treat. Malac., p. 320, 1840; Herrmannsen, Ind. Gen. Malac., Vol. 1, p. 166, 1846, *Tiara isabella* Swainson designated type.

Type (by subsequent designation, Herrmannsen, 1849), *Tiara isabella* Swainson, figured by Reeve, Conch. Icon., Vol. 2, *Mitra*, pl. 6, fig. 42, 1844; China, Recent.

Shell slender, like that of *Mitra*, *s. s.*, but with strong spiral cords; columella with four or five plaits increasing in size posteriorly.

If this subdivision is based primarily on sculpture it is doubtful if it should be considered a natural section. There seem to be many species, which in sculptural characters, are intermediate between those with strong spirals and those with weak or obsolete ones. Some species, such as *Mitra titan* Gabb[1] of the Miocene of Santo Domingo, have strong spiral sculpture when young but lose all or nearly all of it when attaining the adult stage.

Fusimitra Conrad[2] is a very similar group of slender, spirally sculptured species, of which the above mentioned *Mitra titan* Gabb is probably a member. It may be a synonym of *Tiara* Swainson. *Mitra mellingtoni* Conrad is the type of *Fusimitra*, not *M. cellulifera* Conrad, which was not included in Conrad's original list of species.

Uromitra Bellardi[3] has been used for some of the axially plicate, fusiform species.

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[1] Trans. Amer. Philos. Soc., Vol. 15, p. 220, 1873; figured by Pilsbry, Proc. Acad. Nat. Sci. Phila. for 1921, p. 340, pl. 24, figs. 1, 2, January 30, 1922. *Mitra symmetrica* Gabb, *op. cit.*, is the young stage.

[2] Proc. Acad. Nat. Sci. Phila., Vol. 7, p. 261, 1855. Tryon, Fisher, Cossmann and Dall have dated *Fusimitra* Conrad from 1865 (Amer. Journ. Conch., Vol. 1, p. 25) and misinterpreted its characters.

[3] Mem. R. Accad. del. Sci. Torino, Ser. 2, Vol. 38, p. 277, 1887. Type, *Uromitra antegressa* Bellardi.

Mitra sulcata Swainson

Mitra sulcata Swainson, Sowerby, Cat. Shells Tankerville, Appendix, p. 26, 1825; Reeve, Conch. Icon., Vol. 2, *Mitra*, pl. 22, fig. 176, 1844; Tryon, Man. Conch., Ser. 1, Vol. 4, p. 139 in part, pl. 40, fig. 171, 1882; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 212, 1909; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 450, 1926.

Tiara sulcata Swainson, Zool. Illustr., Ser. 2, Vol. 2, pl. 5, figs. 1, 1*a*, 1831.

Shell small, subconical, transversely sulcated, white varied with gray, throat brown; lip crenated (Swainson, in Sowerby, 1825).

Pliocene: Coyote Mountain, Imperial County (Hanna).

Recent: West Coast of Central America southward to Ecuador (Dall).

The biconoidal shape and strong spiral sculpture distinguish this species from all the preceding ones.

Family FASCIOLARIIDAE

Genus FASCIOLARIA Lamarck, 1799

Fasciolaria Lamarck, Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 73, 1799; Woodring, Carnegie Inst., Publ. No. 385, p. 255, 1928.

Type (by monotypy), *Murex tulipa* Linnæus, figured by Reeve, Conch. Icon., Vol. 4, *Fasciolaria*, pl. 4, fig. 9, 1847; Caribbean region; Recent.

Shell stout, fusiform, sometimes very large; aperture long, wide; columella with one to three low, oblique folds; interior of outer lip finely lirate; anterior canal of moderate length, narrow, oblique; sculpture of spiral cords and grooves and with or without axial ribs or nodes on the shoulder.

The type of *Fasciolaria* lacks the strong nodes on the shoulder. The earliest species of the genus in the Caribbean region are of lower Miocene age, according to Woodring. The Pacific coast Eocene species attributed to this genus probably do not belong there.

Fasciolaria princeps Sowerby

Fasciolaria princeps Sowerby, Cat. Shells Tankerville, Appendix, p. 16, 1825; Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 6, Fasciolaire, p. 6, pls. 12, 13, 1840; Reeve, Conch. Icon., Vol. 4, *Fasciolaria*, pl. 1, fig. 3, 1847; Tryon, Man. Conch., Ser. 1, Vol. 3, p. 75, pl. 60, fig. 11, 1881; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 212, 1909; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 448, 1926; Hanna and Hertlein, Vol. 16, pp. 143, 150, 1927.

Pliocene: Coyote Mountain, Imperial County (Hanna); Santa Antonita Point and Ceralbo Island, Gulf of California, Mexico (Hanna and Hertlein).

Recent: Magdalena Bay, Lower California, and Gulf of California, Mexico, south to Panama, Peru, and Galapagos Islands.

Fasciolaria princeps is a well-known, large, southern shell with spiral riblets and a somewhat carinated or shouldered whorl. It lacks the prominent nodes of *F. granosa* Broderip.

Fasciolaria granosa Broderip

Fasciolaria granosa Broderip, Proc. Zool. Soc. London for 1832, p. 32, 1832; Reeve, Conch. Icon., Vol. 4, *Fasciolaria*, pl. 3, fig. 6, 1847; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 212, 1909.

Pleistocene: Coast of Oaxaca, Mexico (coll. by R. H. Palmer).

Recent: West Mexico to Panama and Peru (Dall).

This is a dark-colored species with prominent nodes on the shoulder of the whorls.

Genus FUSINUS Rafinesque, 1815

Fusus Bruguière, Ency. Méth., Vers, p. 15, 1789; Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 73, 1799; Grabau, Smithsonian Misc. Coll., Vol. 44, p. 89, etc., 1904; Dall, Journ. Conch., Vol. 11, pp. 289-297, 1906; Dollfus, Rev. Crit. de Paléozool. for July, 1908, p. 219; Cossmann, Ess. Paléo. Comp., Vol. 8, p. 226, 1909; not *Fusus* Helbling, Abh. Privatges. Naturg., Vol. 4, pp. 116-120, 1779, *fide* Dall, 1906.

Fusinus Rafinesque, Analyse de la Nature, p. 145, 1815, new name for *Fusus* Lamarck; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 36-39, 1909; Woodring, Carnegie Inst., Publ. No. 385, p. 256, 1928.

Type (by monotypy, Lamarck, 1799,—first species assigned to the genus, which was originally described without species), *Murex colus* Linnæus; figured by Reeve, Conch. Icon., Vol. 4, *Fusus*, pl. 3, fig. 11, 1847; Indo-Pacific; Recent.

Shell large, slender, spindle-shaped, with a long, nearly straight, open anterior canal; aperture ovate, outer lip lirate within, parietal wall with callus deposit; sculpture of spiral threads or cords, usually prominent, and of low axial folds or ribs.

This genus has been frequently used improperly for species which are not closely related; likewise, the subdivisions have not been carefully applied. For a discussion of the taxonomy, consult the papers by Dall, Dollfus, and Woodring referred to above.

Section FUSINUS, s. s.

Shell very elongate, spindle-shaped, with a long, nearly straight, partially closed, anterior canal, and a well-defined lip-like callus on the body whorl.

The following species, while somewhat shorter and with a heavier anterior canal than the type species of *Fusinus*, appears to be more closely related to the typical section than to *F. barbarensis* and its allies.

Fusinus dupetit-thouarsi (Kiener)

Fusus dupetit-thouarsi Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, Fuseau, p. 15, pl. 11, 1840; Reeve, Conch. Icon., Vol. 4, *Fusus*, pl. 2, fig. 9, 1847; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924; Hanna and Hertlein Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Type specimen: In the Natural History Museum, Paris ?

Type locality: Coasts of California, probably meaning Lower California, Mexico.

Pliocene: Santa Antonita Point, Gulf of California, Mexico (Hanna and Hertlein).
Pleistocene: Upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).
Recent: Lower California and west coast of Mexico, Galapagos (Reeve).

Fusinus dupetit-thouarsi (Kiener) has a high spire, a long canal, and well-defined spiral sculpture; but the axial ribs are poorly defined or absent. Kiener's figure shows a slight carination on about the middle of the whorls and practically no evidence of axial ribs. Some specimens from Lower California have more or less definite axial folds, but they may not belong to this species. The extent of variation is as yet unknown. Reeve's figure shows axial folds. His specimen came from the Galapagos Islands.

Section GRACILIPURPURA Jousseaume, 1880

Gracilipurpura Jousseaume, Le Naturaliste, An. 2, p. 335, Dec. 15, 1880.

Barbarofusus Grabau and Shimer, North American Index Fossils, Vol. 1, p. 775, 1909, type (by original designation), *Fusus barbarensis* Trask.

Type (by original designation), *Fusus strigosus* Lamarck, figured as *Fusus rostratus* Olivi by Reeve, Conch. Icon., Vol. 4, *Fusus*, pl. 14, species 55, Dec., 1847; Mediterranean.

Shell loosely coiled, less elongate than typical *Fusinus*, with shorter, more widely open anterior canal and less clearly delimited parietal callus.

The southern California species of the section *Gracilipurpura* can be tabulated according to characters as follows:

Shell thin, elongate, without prominent revolving brown lines
  Large, whitish................................*F. barbarensis*
  Small, purplish when fresh......................*F. arnoldi*
Shell heavy, relatively short, with brown revolving lines when fresh
  Medium in size, anterior canal moderately short, axial sculpture very strong...................*F. kobelti*
  Small, anterior canal shorter and axial sculpture not as strong as in *F. kobelti*..................*F. monksæ*

Fusinus barbarensis (Trask)

Plate 27, Figure 11

Fusus barbarensis Trask, Proc. Calif. Acad. Sci., Vol. 1, p. 41, 1855; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 240, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 224, pl. 4, fig. 15, 1903; English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914.

"*Fusus corpulentus* Conrad," Cooper, Calif. State Mining Bureau, Bull. No. 4, Pt. 3, p. 26, 1894, not of Conrad, 1849.

Fusinus barbarensis Trask, Dall, U. S. Nat. Mus., Bull. 112, p. 88, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 177, 1927.

Type specimen: In the California Academy of Sciences.

Type locality: Santa Barbara, California.

Pliocene: Elsmere, Holser, and Pico canyons, Los Angeles County (English); S. D. S. N. H. locality 263, middle Pliocene between Pico Canyon and Fernando Pass, Los Angeles County (H. R. G.).

Pleistocene: "Pliocene" of Deadman Island, common; rare in the lower San Pedro series of Deadman Island and in the upper San Pedro of Deadman Island, San Pedro, and Crawfish George's, Los Angeles County (Arnold); Santa Barbara (Trask; Cooper).

Recent: Heceta Bank, Oregon, to San Diego, California (Dall, 1921).

This species is thin shelled, slender, has a long spire, clear-cut spiral sculpture crossing the axial ribs, and a long anterior canal.

Fusinus barbarensis (Trask) variety **arnoldi** (Cossmann)

Fusus rugosus Trask, Proc. Calif. Acad. Sci., Vol. 1, p. 41, 1855; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 241, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 226, pl. 4, fig. 7, 1903; not *Fusus rugosus* Lamarck, 1804.

Fusus arnoldi Cossmann, Rev. Paléozool., Vol. 7, p. 215, 1903, new name for *F. rugosus* Trask, not Lamarck; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 166, 1924.

Fusinus traski Dall, Nautilus, Vol. 29, p. 54, 1915, new name for *F. rugosus* Trask, not Lamarck; Dall, U. S. Nat. Mus., Bull. 112, p. 88, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 176, pl. 9, fig. 4, 1927.

Type specimen: At the California Academy of Sciences.

Type locality: San Pedro, California.

Pleistocene: "Found only in the lower San Pedro series of Deadman Island," rather rare (Arnold); Santa Barbara (Cooper).

Recent: San Pedro to San Diego, California (Dall, 1921).

This variety is smaller and sometimes has stronger axial ribs than typical *barbarensis*. When fresh it is of a purplish color but fossil specimens are hard to distinguish from the young of the typical variety. Cossmann renamed Trask's homonym and Hanna called attention to it. Dall's name is superfluous.

Fusinus kobelti (Dall)

Fusus kobelti Dall, Proc. Calif. Acad. Sci., Vol. 7, p. 54, 1877; Proc. U. S. Nat. Mus., Vol. 14, p. 177, pl. 6, fig. 4, 1891.

Fusinus kobelti Dall, U. S. Nat. Mus., Bull. 112, p. 88, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 178, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: In the U. S. National Museum.

Type locality: Monterey, California.

Pleistocene: "Saugus" formation near Ventura (Waterfall).

Recent: Monterey to Catalina Island, California (Dall).

Fusinus kobelti Dall is a relatively small, strongly axially sculptured species with a shorter spire and anterior canal than *F. barbarensis*. It is also much heavier and not a typical *Gracilipurpura*.

Fusinus kobelti (Dall) variety **monksae** (Dall)

Fusus robustus Trask, Proc. Calif. Acad. Sci., Vol. 1, p. 41, 1855; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 241, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 226, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; not *F. robustus* Beyrich, 1853.

"*Fusus kobelti* Dall," Cooper, *op. cit.*, p. 240, in part, not of Dall, *fide* Arnold, 1903; also of Delos Arnold, Nautilus, Vol. 10, p. 142, 1897.

Fusinus monksæ Dall; Nautilus, Vol. 29, p. 55, 1915; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 88, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: "Pico" near Ventura (Waterfall); Bath-house Beach, Santa Barbara (Arnold; also Berry, reported questionably).

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); "Found only in the upper San Pedro series; rather common at Old San Pedro" (Arnold); upper San Pedro of Santa Monica, Los Angeles County (Oldroyd Collection at Stanford University).

Recent: Banks Island, British Columbia, to Pequena Bay, Lower California, Mexico (Dall, 1921).

This shell appears to average smaller than *kobelti* and has a shorter anterior canal, in fact the shortest canal of all the shells here placed in *Gracilipurpura*. The axial ribs are not as strong on variety *monksæ* as on the typical variety of *kobelti* and on some specimens of *monksæ* the spiral cords are more prominent than the axial ribs. Both typical *kobelti* and the variety *monksæ* have distinct brown spiral lines when fresh.

There has been considerable confusion among the shells of the *Gracilipurpura* group and misidentifications are common in most collections. If *F. kobelti* is correctly interpreted here, there should be no difficulty in distinguishing it from the large, thin shelled, elongate typical *F. barbarensis*.[1]

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[1] Through the courtesy of Mr. Howard R. Hill, the collections of shells of this group in the Los Angeles Museum have been available for study. Mr. George Willett's collection has likewise been available, in which the four shells discussed above appear to have been correctly segregated.

Fusinus coalingensis (Nomland)

Chrysodomus coalingensis Nomland, Univ. Calif. Publ. Geol., Vol. 9, no. 14, p. 205, pl. 10, fig. 3, February 24, 1916.

Type specimen: In the collection at the University of California.

Type locality: Jacalitos formation of Coalinga region; lower Pliocene.

Pliocene: At the type locality.

This species, as figured, has a long canal like that of *Fusinus barbarensis.*

Fusinus coosensis Dall[1] and *F. empireënsis* Anderson and Martin,[2] both from the Empire formation of Coos Bay, Oregon, appear to represent one or two eroded species of the section *Gracilipurpura. F. fabulator* Nomland,[3] from the Santa Margarita, upper Miocene, of California, is also probably a member of the *Gracilipurpura* group.

Section Harfordia Dall, 1921

Harfordia Dall, U. S. Nat. Mus., Bull. 112, p. 88, 1921.

Type (by monotypy), *Fusinus harfordii* (Stearns), Proc. Calif. Acad. Sci., Vol. 5, p. 79, 1873, separate issued as Conchological Memoranda No. 7, p. 1, August, 1871; figured by Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 178, pl. 6, fig. 6, 1891, Coast of Mendocino County, California; Recent.

Shell Buccinoid in shape but with the anterior canal produced; shell shorter than in typical *Fusinus,* with much shorter anterior canal.

Dall placed *Fusinus luteopictus* in the typical section of *Fusinus* and *Fusinus harfordii* (Stearns) in a new section *Harfordia.* The former is very different from the long, spindle-shaped species with very long anterior canals which are here considered *Fusinus, sensu stricto;* but it is very similar to *F. harfordii* (Stearns), the monotype of *Harfordia* Dall. The differences may be not more than specific.

Fusinus luteopictus (Dall)

Fusus luteopictus Dall, Proc. Calif. Acad. Sci., Vol. 7, p. 3, 1877; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 217, pl. 20, fig. 1, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 225, 1903.

"*Fusus ambustus* Gould," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 664, 1864, in part, not of Gould, *fide* Dall.

"*Fusus geniculus* Conrad," Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 71, 1868-9, in part, not the synonymy, *fide* Dall.

Fusinus luteopictus Dall, U. S. Nat. Mus., Bull. 112, p. 88, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 179, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Monterey, California; Recent.

Pleistocene: Lower San Pedro series of Deadman Island, "rare"; common in upper San Pedro series at Crawfish George's, but rare at San Pedro, Deadman Island, and Los Ceritos (Arnold).

Recent: Monterey, California, to Gulf of California, Mexico (Dall, 1921).

This species has a short anterior canal very unlike that of typical *Fusinus.* It has fold-like axial ribs crossed by strong, raised, strap-like spiral cords.

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[1] U. S. Geol. Surv., Prof. Paper 59, p. 41, pl. 2, fig. 1, 1909.

[2] Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 84, pl. 5, fig. 7, 1914.

[3] Univ. Calif. Publ. Geol., Vol. 10, p. 309, pl. 20, fig. 10, 1917.

Family NEPTUNEIDAE

A number of genera in this family intergrade with the *Muricidæ* and the *Buccinidæ*, and the close relationship of the *Fasciolariidæ* is also clear.

Genus KELLETIA Bayle in Fischer, 1884

Kelletia Bayle, Fischer, Man. Conchyl., fasc. 7, p. 625, 1884, only species *Siphonalia kelletii* Forbes; Cossmann, Ess. Paléo. Comp., Vol. 4, 1901.

Roperia Dall, Nautilus, Vol. 12, p. 5, May, 1898, as section of *Fusus*, type *F. roperi* Dall.

Type (by monotypy), *Kelletia kelletii* (Forbes), southern California; Recent.

Shell of medium size or large, heavy, spire and aperture of about equal length; sculpture consisting of spiral striations or riblets and prominent nodosities on the shoulder of the whorls; aperture ovate, with a moderate anterior canal; outer lip not thickened, with lirations within; inner lip with a sharply delimited callus deposit, smooth; columella long, somewhat sinuous, tapering toward the end; siphonal fasciole large, with an umbilical chink or notch between it and the end of the columella; operculum with an apical nucleus; epidermis absent or a mere film. The type species attains a length of 145 mm. and a breadth of 75 mm.

Subgenus **KELLETIA,** s. s.

Shell large, spiral sculpture differentiated into primary, secondary, tertiary, and even quarternary revolving riblets.

Geologic range: Lower middle Miocene to Recent.

Distribution: Warm and temperate north (and south ?) Pacific Ocean.

Penion Fischer (*op. cit.*, p. 625, type "*Siphonalia*" *dilatata* Quoy) differs in the tabulation or carination on the upper part of the whorls. It might well be considered a subgenus or section of *Kelletia*. *Austrofusus* Kobelt appears to approach *Cantharus* and *Siphonalia* in form. *Searlesia* Harmer differs from typical *Kelletia* in its smaller size and more simple spiral sculpture. It has a more northern habitat than the larger, typical Kelletias. *Kelletia* is closely related to *Cantharus*.

Kelletia (Kelletia) kelletii (Forbes)

Plate 28, Figure 7

Fusus kelletii Forbes, Proc. Zool. Soc. London, Pt. 18, p. 274, pl. 9, fig. 10, 1850.

Siphonalia kellettii Forbes, Lischke, Japanische Meeres-Conchylien, p. 38, pl. 3, figs. 3, 4, 1869; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 663, 1864; Tryon, Man. Conch., Ser. 1, Vol. 3, p. 134, pl. 54, fig. 352, 1881; Dall, Trans. Wagner Inst. Sci., Vol. 3, pt. 1, p. 122, 1890; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 229, pl. 4, fig. 5, 1903.

Siphonalia kelletii Forbes, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 264, 1888.

Fusus roperi Dall, Nautilus, Vol. 12, p. 4, 1898, type of new section *Roperia*, 1898.

Fusus (*Roperia*) *roperi* Dall, Proc. U. S. Nat. Mus., Vol. 24, pl. 34, fig. 3, 1902, in part.

Roperia roperi Dall, of authors.

Siphonalia kelletti Forbes, English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914.

Kelletia kellettii Forbes, Dall, Bull. 112, U. S. Nat. Mus., p. 89, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, October, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 182, 1927.

Fusinus (*Roperia*) *roperi* Dall, Bull. 112, U. S. Nat. Mus., p. 88, 1921, in part; Oldroyd, 1927, in part, see *Tritonalia poulsoni*.

Type specimen: In the British Museum.

Type locality: California; Recent.

Pliocene: Lower Pliocene of Elsmere Canyon and east of Fernando Pass (S. D. S. N. H. localities 203, 216, H. R. G., collector); lower Fernando of Elsmere and Holser canyons (English); middle Pico near Pico Canyon and near Holser Canyon, Los Angeles County (S. D. S. N. H. localities 217*a*, 228, and 230, H. R. G., collector).

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Jordan); Pleistocene of Pacific Beach, San Diego, California (Arnold, 1903); upper San Pedro series of San Pedro, Los Cerritos (*i. e.*, Signal Hill), and Crawfish George's, Los Angeles County (Arnold).

Recent: Santa Barbara, California, south to San Quintin Bay, Lower California, Mexico; also Japan (Dall, 1921).

This well-known species has a higher spire and longer anterior canal than *K. diegoënsis* (Dall) and the nodes are less elongate axially. The spiral sculpture appears to be less sharp. On all the specimens we have seen the upper margins of the whorls encroach considerably on the previous whorls, a character which is somewhat less pronounced on *K. diegoënsis.*

Kelletia kelletii ranges from the lower Pliocene to the Recent in California but appears to have migrated southward during the cold uppermost Pliocene and lower Pleistocene times. "*Fusus*" *roperi* Dall appears to be the young.

Kelletia (Kelletia) diegoensis (Dall)

Chrysodomus diegoënsis Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 298, 1874.

"Shell large, solid, fusiform; apparently, when fresh, of a brownish yellow color; sculpture consisting of regular, even, rounded, spiral ridges, slightly larger toward the anterior end of the last whorl, with from two to four sharp grooves intercalated between each two of the primary ridges, forming fine and small secondary threads of spiral sculpture. On the posterior whorls these are crossed by slightly oblique waves or plications, evanescent toward the sutures and strongest on the apical whorls. On the last whorl and a half these are absent. The posterior fourth of the whorls slightly impressed and the sutures appressed. Whorls eight and a half, periphery rounded. Canal short, recurved, siphonal fasciole short and strong. Outer lip slightly thickened behind the edge, inner lip covered with an even callus. Columella smooth, slightly arched; throat with internal sharp threads, as in *C. dirus*, ending some distance behind the edge of the outer lip.

"Length, 4.0 inches; width, 1.75 inches. Length of aperture, 1.8 inches. Deflection, 42°.

"The upper whorls of this shell bear a slight resemblance to *Siphonalia kellettii;* though the transverse waves are very different from the knobs of that species. There appears to be no special reason for referring the present form to *Siphonalia*, while it presents so great a resemblance to many *Chrysodomi*.

"Habitat, with other Tertiary fossils, in a sand-bed cut through by a well-shaft, at San Diego, California, at a depth below the surface of about one hundred and fifty feet." (Dall.)

Type specimen: Formerly in the museum of the California Academy of Sciences, probably destroyed in the San Francisco earthquake of 1906.

Pliocene: At the type locality, San Diego well, middle Pliocene.

There seems to be a group of Pliocene forms that differ somewhat from the living *kelletii*. They have stronger spiral sculpture, and their nodes are more elongate axially, tending to become obsolete on the body whorl. As these forms are known only by rare or poorly preserved specimens, it is difficult to determine whether they are all varieties of *kelletii* or of one or more extinct Pliocene species. *K. diegoënsis* is now known only from the original description quoted in full above. *K. gilberti* is known from two fairly good specimens described by Moody and from others identified by Waterfall. *K. kettlemanensis* is known from numerous, but so far as the writers know, all poorly preserved specimens. It is likely that these Pliocene forms, insofar as they are distinct from *kelletii*, will fall into the synonymy of *diegoënsis;* but until material can be found in the San Diego formation for comparison, the writers have preferred to list them separately.

K. gilberti appears to have less elongate nodes than *diegoënsis*, more like those of *kelletii;* but it has a shorter anterior canal than *kelletii*. The specimens of *kelletii* from the lower Pliocene of Elsmere Canyon sometimes have nearly obsolete nodes on the body whorl. *K. kettlemanensis* appears to have a lower spire, with a larger apical angle, and seems a little more likely to be distinct. All of these forms have primary, secondary, and tertiary spiral sculpture, which is practically a family character; their nodes run about nine to a whorl; and their rather thick shells have lirations on the insides of the outer lips. They are about twice as large as the forms of the *Searlesia* group.

Kelletia (Kelletia) gilberti (Moody)

Siphonalia gilberti Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 51, pl. 1, figs. 5, 5*a*, 1916.
Cantharus gilberti Moody, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 82, 89, 1929.

Type specimen: In the collection at the University of California, No. 11,077.

Type locality: Fourth and Broadway, Los Angeles, lower part of the upper Pliocene.

Pliocene: At the type locality; also "lower" Pico near Ventura, middle Pliocene (Waterfall).

Kelletia (Kelletia) kettlemanensis (Arnold)

Thais kettlemanensis Arnold, U. S. Geol. Surv., Bull. 396, pp. 27, 69, pl. 15, fig. 4, pl. 21, figs. 1, 1*a*, Jan. 15, 1910; Bull, 398, pl. 37, fig. 4, pl. 43, figs. 1, 1*a* (same figures), 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 213, 221, 1917.

Type specimen: In the U. S. National Museum, No. 165,585.

Type locality: U. S. G. S. locality 4680, base of the Etchegoin formation, lower middle Pliocene, of the Kettleman Hills district, middle California.

Pliocene: At the type locality; common in the Jacalitos formation (Arnold); common in the *Chione elsmerensis* and *Turritella nova* zones, Coalinga district; also lower Sargent (Nomland).

For a discussion of this form and the preceding see *K. diegoënsis*.

Kelletia (? Kelletia) posoënsis (Anderson and Martin)

Siphonalia posoënsis Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 79, pl. 4, fig. 2, 1914.

Type specimen: At the California Academy of Sciences, No. 174.

Type locality: In the bed of a small creek near the center of Sec. 34, T. 28 S, R. 15 E, San Luis Obispo County.

Miocene: At the type locality, probably middle Miocene.

This is a peculiar, elongate species.

Subgenus **SEARLESIA** Harmer, 1914

Searlesia F. W. Harmer, Mon. Palæo. Soc., Vol. 67, Plio. Moll. Gt. Brit., Vol. 1, p. 135, pl. 13, fig. 1, 1914; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 215, 1918.

Type (by original designation), *Trophon costifer* S. V. Wood, figured by Harmer, *op. cit.*, pl. 13, fig. 1; Pliocene of England; Recent, North Atlantic.

"Shell solid, fusiform; apex blunt but not bulbous; ornamented by spiral lines or ribs and by strong longitudinal costæ; canal usually short, open, straight or bending slightly to the left." (S. V. Wood.)

Dall has amplified this description by adding details observed on *Kelletia* (*Searlesia*) *dira* (Reeve). *K. dira* is a typical *Searlesia* very closely related to the British type species. Dall's description follows:

> "Nucleus (of *S. dirus*) smooth, of two laxly coiled smooth whorls changing abruptly into the adult sculpture of few strong axial ribs crossed by numerous spiral threads. The shell-structure subtranslucent, dark colored; the shell short-fusiform, periostracum inconspicuous; aperture shorter than the spire, the outer lip thickened and internally lirate; the body callous, with a narrow chink between the reflected enamel and the strong siphonal fasciole; canal short, open, slightly recurved. Radular formula 1/2: 1/3: 1/2, the medium rachidian cusp longer than the others."

Kelletia (Searlesia) dira (Reeve)

Plate 28, Figure 6

Buccinum dirum Reeve, Conch. Icon., Vol. 3, *Buccinum*, pl. 12, fig. 92, Dec., 1846.

Fusus incisus Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 141, 1849; U. S. Exploring Exped., Vol. 12, p. 232, 1852, Atlas Mollusca, pl. 16, figs. 283, 283*a*, 1856; Harmer, Mon. Palæo. Soc., Vol. 67, Plio. Moll. Gt. Brit., Vol. 1, p. 138, 1914.

Euthria dira Reeve, Tryon, Man. Conch., Ser. 1, Vol. 3, p. 151, pl. 72, figs. 232, 233, 1881.

Chrysodomus dirus meridiei Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 52, pl. 1, figs. 9*a*, 9*b*, 1916.

Searlesia dira Reeve, Dall, U. S. Nat. Mus., Bull. 112, p. 98, pl. 8, fig. 1, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 237, 1927.

Shell of moderate size, heavy, stoutly sub-fusiform; whorls ventricose; spiral sculpture of rather uniform spiral cords and occasional intercalated threads; axial sculpture of broad axial undulations becoming obsolete on the body whorl; aperture ovate, outer lip simple, with lirations within; anterior canal short, slightly reflexed; inner lip slightly concave, with a thin callus wash; siphonal fasciole variable in strength, often with an umbilical chink between it and the lower extension of the inner lip. Length, 41 mm.; maximum width, 19 mm.

Pliocene: "Fernando" at Fourth and Broadway, Los Angeles (Moody).
Pleistocene: Santa Barbara (Dall, 1921).
Recent: Chirikoff Island, Alaska, to Monterey, California.

This is a rather common species on the rocky coasts of California at least as far south as Monterey. A large series of these shells at Stanford University shows variation in height of spire, shape of aperture, length and amount of twist of the anterior canal, and thickness of the outer lip. Specimens occasionally attain a length of over 50 mm.

"*Fusus incisus*" Gould, as figured in the Exploring Expedition Atlas, was applied to a peculiar specimen of *dira* with axial undulations on the body whorl. Some large specimens in the collection at Stanford University have these rib-like irregularities on the ultimate whorl, but they are abnormal. The variety *meridiei* Moody, based upon a single specimen, is too close to living variants to warrant a separate name. "*Chrysodomus*" *portolaensis* (Arnold) is very closely related and similar in appearances. "*Chrysodomus*" *sitkensis* (Middendorff) is probably a synonym. *K. dira* (Reeve) is closely related to *K. costifera* (S. V. Wood),[1] the type of the genus, which occurs in the Red Crag of England. The typical form of the English species has stronger axial ribs, and these ribs are also present on the body whorl; but some of the variants are much like California specimens of *K. dira*.

Kelletia (Searlesia) dira (Reeve) variety **portolaensis** (Arnold)

Fusus (*Buccinofusus*) *portolaensis* Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 385, pl. 37, fig. 8, Aug. 8, 1908.

Chrysodomus portolaensis Arnold, U. S. Geol. Surv., Bull. 396, p. 158, pl. 27, fig. 9, January 15, 1910; Arnold and Anderson, Bull. 398, pl. 49, fig. 9, 1910.

Type specimen: In the U. S. National Museum, No. 165,473.

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[1] *Trophon costiferum* S. V. Wood, Mon. Palæo. Soc., Vol. 1, Crag. Moll., Pt. 1, p. 48, pl. 6, fig. 9, 1848.

Type locality: White Creek, 19 miles northwest of Coalinga, Fresno County; Etchegoin Pliocene.

Pliocene: At the type locality; on Sausal Creek, one-half mile southwest of Portola, Santa Cruz Quadrangle (Arnold, 1908); several localities in eastern Monterey County and western Fresno County.

This variety is so close to the typical form that the distinctions may be found to lack significance. It appears to have a longer anterior canal and the spiral cords may be slightly heavier. It is possible that the variety *meridiei* is a synonym of *portolaensis* rather than of the typical form. *Kelletia branneri* (Clark and Arnold)[1] is closely related to *K. dira* and is very similar to variety *portolaensis* (Arnold). *K. dalli* (Clark),[2] of the San Lorenzo Oligocene, is another closely related form.

Genus CANTHARUS Bolten, 1798

Cantharus Bolten, Mus. Boltenianum, p. 132, 1798; Meek, Rept. U. S. Geol. Surv. Territories, Vol. 9, p. 377, 1876; Cossmann, Ann. Soc. Roy. Malac. Belg., Vol. 24 (Ser. 4, Vol. 4), p. 137, 1889; Iredale, Proc. Malac. Soc. London, Vol. 10, p. 221, 1912; Suter, Man. New Zealand Moll., p. 393, 1913; not *Cantharus* Cuvier, 1829, Pisces; not *Cantharis* Linnæus, 1758, Insecta.

"Rapana β" Schumacher, Ess. Nouv. Syst. Hab. Vers Test., p. 214, 1817.

Pollia Gray in Sowerby, Gen. Rec. Foss Shells, Vol. 2, footnote in text to pls. 256, 257, 1834; Gray, Zool. Beechey's Voy., p. 111, 1839, type, by monotypy, *Triton undosus* Lamarck; Iredale, Proc. Malac. Soc. London, Vol. 10, p. 221, 1912 (in discussion of *Quoyula*).

Tritonidea Swainson, Treat. Malac., p. 302, 1840; Gray, Proc. Zool. Soc. London, Pt. 15, p. 133, 1847, type *Buccinum undosum* Linnæus; Iredale, Proc. Malac. Soc. London, Vol. 10, p. 221, 1912.

Solenosteira Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 122, 1890, type *Pyrula anomala* Reeve.

Type (by subsequent designation, Suter, 1913), *Cantharus globularis* Bolten = *Buccinum tranquebaricum* Gmelin; Indian Ocean, Recent; figured by Reeve, Conch. Icon., Vol. 3, *Buccinum*, sp. 17, pl. 3, Dec., 1846.

Shell of moderate size, heavy, bucciniform but with anterior portion longer; aperture and spire of about equal length; sculpture consisting of spiral riblets and axial undulations; inner side of outer lip with crenulations; columella nearly smooth or with a few small ridges.

"Rapana β" of Schumacher was exemplified by only one species, *"Rapana flavescens,"* which is a new name for the *"Nassa undosa tranquebarica"* of Chemnitz (Conch. Cab., Vol. 4, p. 35, pl. 123, figs. 1146, 1147, 1780), now more properly called *Cantharus tranquebaricus* (Gmelin), the type of *Cantharus* Bolten. The *"Rapana α* of Schumacher had for sole example *"Rapana foliacea,"* which is the *Rapana bezoar* Linnæus, 1767, and is therefore very different from Schumacher's *β* division. *Pollia* Sowerby is synonymous, as is also *Tritonidea* Swainson. *Solenosteira* Dall has a longer aperture and canal but is very close in other respects to the typical form.

Siphonalia A. Adams,[3] typified by *S. cassidariæformis* (Reeve), is similar in form but can be distinguished by its thin shell and lack of conspicuous epidermis. *Siphonalia* is a warm-water Oriental genus, which is well represented in the earlier Tertiary of California, along with several other Asiatic groups. *Pisania* Bivona is based on *M. pusio* Linnæus, which is an elongate species, with a smooth surface.[4]

Cantharus probably began in the Eocene and is well represented in the present tropical seas.

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[1] Univ. Calif. Publ. Geol., Vol. 14, p. 159, pl. 30, figs. 3*a-b*, 1923.

[2] Univ. Calif. Publ. Geol., Vol. 11, p. 175, pl. 20, figs. 5, 9, 15, 1918.

[3] Annals and Mag. Nat. Hist., Ser. 3, Vol. 11, p. 202, 1863; Cossmann, Ann. Soc. Roy. Malac. Belgique, Vol. 24, (Ser. 4, Vol. 4), p. 149, 1889; "type: *S. cassidariæformis* (Reeve)."

[4] *Pisania* Bivona, Effem. Scien. Lett. Sicilia, Vol. 2, p. 8, pl. 2, figs. 6*a-d*, 1832; Herrmannsen, Indicis Gen. Malac., Vol. 2, pp. 273, 274, Dec. 7, 1847; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 25, 1882; Cossmann, Ann. Soc. Roy. Malac. Belg., Vol. 24, p. 139, 1889.

Cantharus fortis (Carpenter)

Plate 28, Figure 2

Pisania fortis Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 17, p. 277, 1866; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 260, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 227, 1903; McLaughlin and Waring, Bull. 69, Calif. State Mining Bureau, Map Folio, pl. 1, fig. 48, 1914.

Cantharis fortis Carpenter, Carson, Bull. So. Calif. Acad. Sci., Vol. 24, pt. 2, p. 33, August 17, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 79, 89, pl. 5, figs. 5, 6, 1929.

Shell with strong, rounded spiral ribs and smaller interribs, also prominent axial ribs which are crossed by the spiral sculpture without interruption or modification; body whorl slightly shouldered, the axial ribs obsolete on the lower portion.

Type locality: Santa Barbara; Pleistocene.

Pleistocene: Santa Barbara (Carpenter; Cooper); Pacific Beach, San Diego County; upper San Pedro series of San Pedro and Deadman Island, rare (Arnold, 1903).

This species is very similar to the living *Cantharus insignis* (Reeve) and is unquestionably closely related.

Cantharus fortis (Carpenter) variety **angulatus** (Arnold)

Pisania fortis Cpr. var. *angulata* Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 536, pl. 50, figs. 6, 7, 1907; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, pl. 40, figs. 6, 7, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914; Nomland, Vol. 10, p. 221, 1917.

Solenosteira angelensis Carson, Bull. So. Calif. Acad. Sci., Vol. 24, pt. 2, p. 32, pl. 1, figs. 3, 5, August 17, 1925.

Cantharus angulatus Arnold, Carson, *op. cit.*, p. 33, 1925.

Broader than typical *Cantharus fortis* and with an angulated shoulder on the whorls. Length, 80 to 100 mm., width, 40 mm.

Type specimen: In the U. S. National Museum, No. 164,975.

Type locality: Third Street tunnel, city of Los Angeles; Pliocene.

Pliocene: Lower Pliocene of Elsmere Canyon, two and a half miles southeast of Newhall (Arnold); lower Fernando of Holser Canyon, Los Angeles County (English); Third Street tunnel in Los Angeles (Arnold); lower Purisima of middle California (English); lower Merced and Etchegoin formations of middle California (Nomland); mouth of Brea Canyon, Puente Hills, Los Angeles County (Carson, as *Solenosteira angelensis*); "lower Pico," middle Pliocene, near Ventura (Waterfall).

The spiral ribs on this variety do not seem to be so prominently elevated as on most of the specimens of the Pleistocene typical variety. The axial ribs are likewise nearly or entirely wanting. This form seems to grade into *humerosus* in the lower Pliocene of Elsmere Canyon.

Cantharus humerosus (Gabb)

Plate 28, Figure 3

Neptunea humerosa Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 45, 71, pl. 14, fig. 3, 1868-9; Cooper, Calif. State Mining Bureau, Bull. 11, p. 80, 1896; Arnold, U. S. Geol. Surv., Prof. Paper 47, p. 27, 1906; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, p. 25, 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 212, 1914; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 395, pl. 32, figs. 2, 3, 1927.

Chrysodomus arnoldi Rivers, Bull. So. Calif. Acad. Sci., Vol. 3, no. 5, p. 70, May, 1904; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 526, pl. 50, fig. 10, 1907 (listed questionably); English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914 (not positively identified).

Chrysodomus cf. *arnoldi* Rivers, Arnold, U. S. Geol. Surv., Bull. 309, p. 252, pl. 40, fig. 10, 1907.

Cantharus breaensis Carson, Bull. So. Calif. Acad. Sci., Vol. 24, pt. 2, p. 31, pl. 1, fig. 2, Aug. 17, 1925.

Cantharus ashleyi Carson, *op. cit.*, p. 31, pl. 1, figs. 6, 7, 1925.

Cantharus elsmerensis Carson, *op. cit.*, p. 32, pl. 1, fig. 4, 1925.

Cantharus arnoldi Rivers, Carson, *op. cit.*, p. 34, pl. 1, fig. 1, 1925.

Shell of medium size, whorls ventricose, with a shoulder of variable strength at the upper third, suture emphasized by a collar; aperture ovate, anterior canal twisted, columella incrusted, siphonal fasciole prominent; sculpture of fine spiral cords or threads.

Type specimens: Lectotype of *humerosus*, in the Academy of Natural Sciences of Philadelphia (*fide* Stewart); of *arnoldi*, unknown to the authors; of *breaensis*, *ashleyi*, and *elsmerensis*, at Stanford University.

Type locality: Pliocene of San Fernando Pass, Los Angeles County.

Pliocene: Near Wiley's on the San Fernando Pass, Los Angeles County (Gabb); lower Fernando of Elsmere Canyon (Eldridge and Arnold; English); lower Pliocene of Elsmere Canyon, and middle Pliocene of San Fernando Pass and thence occurring all along the outcrop to Pico Canyon and to Holser Canyon, various S. D. S. N. H. localities (coll. by H. R. G.); Gavin Canyon, west of San Fernando Pass and from near San Fernando Tunnel (as *Cantharus ashleyi*, Carson); Brea Canyon, Puente Hills (as *Cantharus breacnsis*, Carson), all Los Angeles County.

? Pleistocene: "Pliocene," one specimen from Crawfish George's near San Pedro, Los Angeles County (Rivers).

Cantharus humerosus (Gabb) is common in the Pico formation of the eastern portion of the Santa Clara Valley and around San Fernando Pass. The one Pleistocene record might have been occasioned by some error in labeling, and in any case is probably an error.

"*Chrysodomus*" *kernensis* Anderson and Martin,[1] from the lower Miocene of Kern River, Kern County, appears to belong to this group. It has a very small siphonal fasciole and intercalary spirals. It is of the general shape of *Neptunea antiqua* and shows how difficult it is to separate *Cantharus* from *Neptunea*. *C. humerosus* is about midway between the type of *Neptunea* and the type of *Cantharus*, but it is here placed with the latter because of its relation to *fortis*, its thick shell for a rather small size, and the lirations on the interior of the outer lip, mentioned by Gabb.

Cantharus anomalus (Reeve)

Pyrula anomala Reeve, Conch. Icon., Vol. 4, *Pyrula*, species 9, pl. 3, figs. 9, 12 (typical), June, 1847.

Pyrula pallida Broderip, in Sowerby, Thes. Conch., Vol. 4, *Pyrula*, p. 100, sp. 3, pl. 5, figs. 37, 38, 1880.

Solenosteira (*Pyrula*) *anomala* Reeve, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 122, 1890.

Solenosteira anomola Reeve, Dall, Nautilus, Vol. 32, p. 23, 1918; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 453, 1926.

Solenosteira pallida Broderip and Sowerby, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Pliocene: Imperial formation, Coyote Mountain, Imperial County, California (Hanna).

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Dall, 1918, as *S. anomola* Reeve; Jordan, as *S. pallida* B. and S.).

Recent: San Ignacio, west coast of Lower California, to Panama.

There is little doubt that the *Pyrula anomala* Reeve, and the *P. pallida* Broderip (MS. ?) in Sowerby, are the same species. Sowerby's figures seeem to be somewhat intermediate between Reeve's two extremes. *C. anomalus* is the type of *Solenosteira*.

Cantharus elegans (Gray)

Triton (*Pusio*) *elegans* Gray, in Griffith's Cuvier, Anim. Kingd. Moll., p. 600, pl. 25, fig. 2, 1834.

Cantharus elegans Gray, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 213, 1909; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Pleistocene: Lower Quaternary of Magdalena Bay, Lower California, Mexico (Jordan); upper Pleistocene of the coast of Oaxaca, Mexico (coll. by R. H. Palmer, specimens in the collection at Stanford University).

Recent: Point Abreojos, Lower California, Mexico, to Peru (Jordan).

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[1] Frank M. Anderson and Bruce Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 78, pl. 4, figs. 6a, 6b, December 30, 1914.

Cantharus sanguinolentus (Duclos)

Purpura sanguinolenta Duclos, Guérin, Mag. de Zool., Vol. 5, p. 22, fig. 1, 1833.
Cantharus sanguinolentus Duclos, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 214, 1909.

Pleistocene: Upper Pleistocene, coast of Oaxaca, Mexico (collected by R. H. Palmer).
Recent: Mazatlan and south to Guayaquil (Dall, 1909).

"*Murex*" *vibex* Broderip[1] of the Panama and the west Mexican regions may be a *Cantharus*. It is certainly not a *Murex*.

Genus MACRON H. and A. Adams, 1853

Macron H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 132, 1853, list includes *æthiops* Reeve, and *kellettii* A. Adams; Melvill, Journ. Conchology, Vol. 10, p. 326, 1903; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 141, 1901.

Type (by subsequent designation, Cossmann 1901), *Macron kellettii* (A. Adams).

Shell ovate, heavy; strongly spirally sculptured or smooth; whorls moderately ventricose, body whorl much larger than penultimate whorl; aperture ovate, outer lip with a tooth-like projection anteriorly, inner lip gently concave; anterior canal short, notched; epidermis strong, brownish or chestnut; operculum horny, with apical nucleus. Length, 10 to 100 mm.

Geologic range: Miocene to Recent.

The type of this genus is a variety of *M. æthiops* (Reeve). *Pseudoliva* Swainson[2] seems to be related to *Macron*. The type of *Pseudoliva* has a very short, sharp spire. It is figured by Chemnitz, Swainson, the Adams brothers and others. The operculum as figured by H. and A. Adams (and reproduced by Fischer, 1884) has a medio-lateral nucleus, but a specimen of *plumbea* in the Oldroyd Collection at Stanford University has an apical nucleus like that of the *Macron* operculum.

Macron æthiops (Reeve)

Buccinum æthiops Reeve, Conch. Icon., Vol. 3, pl. 13, fig. 108, 1847.
Macron æthiops Reeve, Melvill, Journ. Conch., Vol. 10, no. 11, p. 327, 1903; Dall, Nautilus, Vol. 32, p. 23, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Shell large, with strong, rather flat, spiral cords separated by wide interspaces, and a prominent, subsutural, channeled tabulation; siphonal fasciole prominent. Large specimens measure 95 mm. in length and 55 mm. in width.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall; Jordan, 1924, as "lower Quaternary"); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).
Recent: San Quintin Bay to Gulf of California, Mexico (Jordan, 1924).

The typical *æthiops* differs from the variety *kellettii* in the prominence of the spiral sculpture and subsutural tabulation. *M. hartmanni* Hertlein and Jordan, a strongly tabulated variety, has less heavy spiral sculpture and, so far as known, does not attain the size of *M. æthiops*.

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[1] Proc. Zool. Soc. London for 1832, p. 175; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 34, fig. 175, 1845.

[2] Treat. Malac., pp. 82, 306, text fig. 3*a*, 1840, type designation (p. 82) "*Buccinum plumbeum* of Linnæan authors"; (p. 306) monotype *P. plumbea* Chemnitz (Neues Systematisches Conchylien Cabinet, Vol. 11, p. 86, pl. 188, figs. 1806-7, dated 1795).

Macron æthiops (Reeve) variety **kellettii** (A. Adams)

Plate 28, Figure 8

Pseudoliva kellettii A. Adams, Proc. Zool. Soc. London for 1853, p. 185.
Macron kellettii A. Adams, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 664, 1864; Tryon, Man. Conch., Ser. 1, Vol. 3, p. 214, pl. 82, fig. 477, 1881; Cooper, Calif. State Mining Bureau, Bull. 4, Pt. 3, p. 27, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 230, 1903; Melvill, Journ. Conch., Vol. 10, p. 326, 1903.
Macron æthiops kellettii A. Adams, Dall, U. S. Nat. Mus., Bull. 112, p. 89, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 183, 1927.

Shell like that of *M. æthiops*, but with very faint or obsolete spiral sculpture on the upper part of the body whorl and the spire.

Pliocene: Ventura County (Cooper), may be Pleistocene.
Pleistocene: One specimen in upper San Pedro series at San Pedro (Arnold); upper Pleistocene at Signal Hill (specimen in Oldroyd Collection at Stanford University); Pleistocene of San Joaquin Bay, Orange County (Cooper).
Recent: Catalina Island ? (Cooper); Lower California and the Gulf of California (Dall, 1921).

The strong spiral sculpture of the typical *æthiops* is only present on the lower part of the body whorl of variety *kellettii*. *Macron orcutti* Dall,[1] of the Recent fauna of Magdalena Bay, has fine, close spiral striations and no channel at the suture. *Macron merriami* Arnold[2] from the lower Miocene at the head of Topanga Canyon, three miles south of Calabasas, Los Angeles County, is much like variety *kellettii*, but is a more slender shell with a narrower tabulation below the suture. Arnold suggests that it may be the precursor of *kellettii*, though it would seem that *M. hartmanni* Hertlein and Jordan is more apt to be a direct ancestor.

Macron lividus (A. Adams)

Pseudoliva livida A. Adams, Proc. Zool. Soc. London, Pt. 22, p. 136, 1854.
Macron lividus A. Adams, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 664, 1864; Keep, West Coast Shells, p. 20, fig. 2, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 230, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 89, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 183, 1927.
Macron livida A. Adams, Melvill, Journ. Conch., Vol. 10, p. 329, 1903.

Shell small, elongate; whorls moderately ventricose; sculpture consisting of faint spiral threads on the basal portion of the body whorl. Large specimens measure 23 mm. in length and 13 mm. in width.

Pleistocene: One specimen from the upper San Pedro Pleistocene at the "lumber yard," San Pedro (Arnold).
Recent: Farallone Islands, California, to San Bartolomé Bay, Lower California, Mexico (Dall, 1921).

From the Miocene of Lower California, southwest of San Ignacio, Hertlein and Jordan[3] described *Macron hartmanni*. It appears to be related to *Macron æthiops* variety *kellettii*, but the spiral sculpture on the lower part of the body whorl is finer and the posterior canal is a little more distant from the body whorl. It was collected from the Isidro formation, associated with *Turritella ocoyana* Conrad.

Genus VOLUTOPSIUS Mörch, 1857

Strombella Gray, Guide Moll. Brit. Mus., p. 13, Jan., 1857, not *Strombella* Schlüter, Syst. Conch. Samml., p. 22, 1838.
Volutopsius Mörch, Fort. ov. Grönl. Blöddyr., p. 13, April, 1857; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 221, 1918.
Volutopsis Mörch, Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 57, 1873; G. O. Sars, Moll. Reg. Arct. Norv., p. 268, 1878.

Type (*fide* Dall, 1918), *Volutopsius largillierti* (Petit de la Saussaye), described as *Fusus* in the Journ. de Conchyl., Vol. 2, p. 254, pl. 7, fig. 6, 1851; also figured by Tryon as *Neptunea* (*Volutopsius*) *norvegica* Chemnitz, Man. Conch., Vol. 3, p. 119, pl. 48, figs. 276, 277, pl. 49, figs. 278, 279, pl. 50, fig. 288, 1881, the figure 278 being a reproduction of Petit's; see also Harmer, Mon. Palæo. Soc., Vol. 67, Plio. Moll. Gt. Brit., Vol. 1, p. 152, pl. 15, fig. 2, 1914.

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[1] Proc. Biol. Soc. Washington, Vol. 31, p. 5, 1918.

[2] Proc. U. S. Nat. Mus., Vol. 32, p. 529, pl. 41, figs. 4, 4a, June 15, 1907; also figured in U. S. Geol. Surv., Bull. 309, pl. 28, figs. 4, 4a, 1907.

[3] Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 629, pl. 21, fig. 5, 1927.

Shell resembling that of *Neptunea*, but with a large body whorl, a more ample aperture, a short, hardly differentiated anterior canal, and a short, blunt, few-whorled spire.

Volutopsius eurekaensis Martin

Volutopsius eurekaensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 190, pl. 19, fig. 3, 1914.

Type specimen: In the collection at the University of California.

Type locality: Near the mouth of Bear River, Humboldt County, California; upper Miocene (Martin), possibly lower Pliocene.

Miocene or *Pliocene:* At the type locality (Martin).

Volutopsius mesleri (Dall)

Chrysodomus mesleri Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 28, pl. 5, figs. 2, 3, 1920.

Type specimen: In the U. S. National Museum.

Type locality: Center Creek mines, two miles north of Nome, Alaska; Pliocene.

Pliocene: At the type locality and questionably from Center Creek, one and a half miles north of Nome, Alaska (Dall).

This species is based upon two badly worn fragments. It has strong, rounded nodes and was said by Dall to be nearest allied to *N. satura* (Martyn). However, it seems more probable that Dall's fragments are from an immature individual of *Volutopsius kennicotti* (Dall).[1] *Volutopsius* seems to be very closely related to typical *Neptunea*, being distinguished typically by its relatively enlarged body whorl and weak sculpture. The species *kennicotti* (species, or variety of *behringii*) appears to be intermediate between *Neptunea satura* and *Volutopsius*. Its strong, curved, pinched, axial waves may represent an accentuation of axial irregularities such as are sometimes found on *antiqua*, the curving of the waves being, perhaps, a more unusual feature than their elevation.

The form *kennicotti* has traditionally been assigned to *Beringius*, a name that Dall was afraid would fall as a synonym of *Jumala*. However, the type of *Beringius* is *Neptunea* (*Beringius*) *crebricostata* (Dall),[2] which has a shell with coarse spiral ridges like those of *Neptunea decemcostata*. It can be distinguished from *Neptunea* only by its short anterior canal and is more likely to conflict with *Ancistrolepis* than with *Jumala*. It is no more like *Jumala* than it is like *kennicotti*. *Jumala*[3] may be useful as a section of *Volutopsius* with a high spire. It has very weak sculpture, with a short anterior canal.

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[1] *Buccinum kennicotti* Dall, Amer. Journ. Conch., Vol. 7, p. 108, pl. 15, fig. 1 (expl. of plate on p. 160), Nov. 2, 1871; figure reproduced by Tryon, Man. Conch., Vol. 3, p. 294 (expl. plate), pl. 50, fig. 290, 1881, who considers it conspecific with *Tritonium behringii* Middendorff, which he describes and figures, *op. cit.*, p. 121, pl. 49, fig. 280, pl. 50, fig. 289, as *Neptunea behringii*, assigning Dall's *kennicotti* to the variety *castanea* Mörch.

[2] Proc. Calif. Acad. Sci., Vol. 7, p. 6, 1877; Sci. Res. Expl. Alaska, pl. 2, figs. 1*a-c*, proofs sent to friends in 1879 but not really published until later; Proc. U. S. Nat. Mus., Vol. 24, pl. 35, fig. 1, 1902; also figured by Tryon, Man. Conch., Vol. 3, p. 118, pl. 48, fig. 274, 1881, and by Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 193, pl. 23, fig. 1, 1927.

[3] *Jumala* Friele, Norwegian North Atlantic Expedition, 1, p. 6, 1882; Dautzenberg and Fischer, "Moll. Prov. Camp. de l'Hirondelle et de la Princess-Alice," Rés. Camp. Sci. Albert I, Prince de Monaco, Vol. 37, p. 64, 1912; + *Ukko*, Friele in Norman, Ann. and Mag. Nat. Hist., Ser. 6, Vol. 12, p. 352, Nov., 1893, new name for *Jumala* proposed because it was discovered that Jumala is the term used by the Christian Lapps for God. The type is *Fusus turtoni* Bean, Loudon's Mag. Nat. Hist., Vol. 7, p. 493, 1834; Howse, Ann. and Mag. Nat. Hist., Ser. 1, Vol. 19, p. 160, pl. 10, figs. 6-10, 1847; Reeve, Conch. Icon., Vol. 4, *Fusus*, pl. 20, species 83, 1848; *Neptunea* (*Volutopsius*) *turtoni* Bean, Tryon, Man. Conch., Vol. 3, p. 119, pl. 48, fig. 275, pl. 49, figs. 281, 282, 283, 1881; coasts of Britain.

Dall reported two forms[1] of *Volutopsius* from the fossil beds at St. George Island (Pribilof Islands) which he believed to be related to *V. malleatus*[2] and *V. regularis*[3] Dall. The age of the deposit was believed to be late Pliocene.

Subgenus **PYRULOFUSUS** Beck in Mörch, 1869

Pyrulofusus (Beck MS.) Mörch, Mém. Soc. Malac. Belgique, Vol. 4, p. 20, 1869, sole example, *Fusus deformis* Reeve; Friele, Jahrb. Mal. Ges., Vol. 6, p. 280, 1879; N. Atl. Exp., Vol. 1, p. 8, pl. 1, fig. 8, pl. 4, figs. 11-13, 1882; Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 523, 1902; Dautzenberg and Fischer, Res. Camp. Sci., Albert I, Prince de Monaco, Pt. 37, p. 67, pl. 1, figs. 6, 7, 1912; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 223, 1918.
Heliotropis Dall, Proc. Calif Acad. Sci., Vol. 5, p. 61, April, 1873.
Pyrolofusus Mörch, Krause, Arch. f. Naturg., Vol. 51, p. 282, 1885.
Pyrolofusus (Beck) Mörch, Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 523, 1902.

Type (by monotypy, *fide* Dall, 1918), *Fusus deformis* Reeve, Conch. Icon., Vol. 4, *Fusus*, pl. 12, figs. 45*a-b*, Dec., 1847, "Hab. Spitzbergen."

Shell large, usually sinistral; spire low, of few whorls, with a large nucleus; sculpture of spiral striations or threads and a few rude axial waves; aperture ample, with a very short or indefinite anterior canal, tapering columella, and no siphonal fasciole; operculum horny, small, with apical nucleus.

This subgenus is essentially a sinistral *Volutopsius* with stronger axial sculpture.

Volutopsius (Pyrulofusus) schraderi (Dall)

Pyrulofusus schraderi Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 29, pl. 5, figs. 10, 13, 1920.

Type specimen: In the U. S. National Museum.

Type locality: Forty miles up Colville River from its mouth at the Arctic coast, in silt beds, 80 feet above the river, five to fifteen feet below the base of loess, twenty feet below the surface of the soil; supposedly Pliocene.

Pliocene: At the type locality (Dall).

Dall reported[4] two fossil forms of *Pyrulofusus* from the "late Pliocene" of St. George Island (Pribilof Islands), which he suggested were related to *P. deformis* "Gray" (?) and *P. harpa* Mörch.

Genus **NEPTUNEA** Bolten, 1798

Tritonium Müller, Zool. Danicæ Prodr., p. 243, 1776, list includes *T. undatum*, *T. antiquum*, *T. despectum*, and others, in part only, not the type, *Buccinum undatum* Linnæus, cited by Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 209, 1817, *fide* Stewart, Special Publ. No. 3, Acad. Nat. Sci. Phila., p. 40, 1930; Gray, Proc. Zool. Soc. London, Pt. 15, p. 137, 1847, type cited *Murex antiquus;* not of Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 394, 1927, type cited *Buccinum undatum* Linnæus.
Neptunea Bolten, Mus. Boltenianum, p. 115, 1798; Mörch, Cat. Yoldi, p. 104, 1852; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 99, type *Fusus antiquus* L., pl. 4, fig. 15, 1901; Iredale, Proc. Malac. Soc. London, Vol. 14, p. 206, 1921; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 393, 1927; not "*Neptunea* Bolten" Dall.

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[1] Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919.

[2] Proc. U. S. Nat. Mus., Vol. 7, p. 525, 1884, as *Strombella*.

[3] Proc. Calif. Acad. Sci., Vol. 5, p. 60, pl. 2, fig. 6, 1873, as *Volutopsis beringi* Midd., var. *regularis*.

[4] Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919.

Not *Tritonium* Link, Beschreibung Naturalien-Sammlung der Universität zu Rostock, Erste Abtheilung, p. 121, dated December 25, 1806.

Chrysodomus Swainson, Treat. Malac., pp. 90, 308, 1840; Herrmannsen, Indicis Gen. Malac., Vol. I, p. 234, 1847, type cited *Fusus despectus;* Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 521, 1902; Proc. Biol. Soc. Washington, Vol. 31, p. 137, 1918; Proc. U. S. Nat. Mus., Vol. 54, p. 214, 1918; Proc. Malac. Soc. London, Vol. 15, p. 36, 1922.

? Beringius Dall, Sci. Res. Expl. Alaska, pl. 2, legend, proofs sent to friends in 1879; Proc. U. S. Nat. Mus., Vol. 9, p. 304, 1886; Vol. 17, p. 710, 1894.

Type (by subsequent designation, Cossmann, 1901), *Murex antiquus* Linnæus. See plate 28, figure 10, of *N. antiqua,* and figures 1*a*, 1*b*, of *despecta,* which is sometimes considered a variety of *antiqua.*

Shell moderately large, elongate-ovate to subfusiform, ventricose; sculpture mostly spiral; outer lip usually simple; anterior canal of moderate length, slightly curved.

Geologic range: Cretaceous to Recent.

Distribution: Cold and temperate waters.

As Gray's designation of *Murex antiquus* for the type of *Tritonium* Müller is perfectly clear and valid, only Schumacher's rather questionable designation of type prevents the use of *Tritonium* for this genus. If Schumacher's designations should not be accepted, *Neptunea* would fall as an exact synonym, having the same type as *Tritonium. Chrysodomus,* of which the type is "*Fusus*" *despectus,* cannot be used even as a section to include the tabulated species, since some varieties of *Neptunea antiqua* have tabulations well developed. This will be apparent to anyone examining a large series of *N. antiqua.* This species and several of its variants, including variety *despecta,* are beautifully figured by Dautzenberg and Fischer in the magnificent volume on the mollusks of the Hirondelle and Princess Alice Expedition in the North Sea.[1]

Beringius Dall was supposed to have been established in 1879, that name having been used in the explanation of a plate of which Dall had fifty proof copies distributed to conchologists, but its status is questionable as of that date. The type is conchologically similar to the *N. lirata* group.

"*Chrysodomus*" *giganteus* Reagan, 1909, may, like *Cymatium pacificum* Dall, be a synonym of *Neptunea lirata.* In the California Tertiary there are a number of species which have been improperly assigned to "*Chrysodomus.*" It is often very difficult to assign fragmental or badly eroded specimens to the proper genus, and it would be better for all concerned if such specimens were described but not named until identifiable type material can be found. A number of forms have been named and placed in genera from which they will have to be removed eventually when better material shows more of the shell characters. The "*Chrysodomus packardi*" Nomland, which Hanna renamed "*Chrysodomus ?*" *prænominata* (new name for *C. packardi* Nomland, not *C. packardi* Weaver, 1916), appears to be a *Tritonalia.* "*Chrysodomus*" *imperialis* Dall has a low spire, a large pyriform body whorl, and other characteristics of *Thais.* It is represented by good specimens, but the writers have not been able to study them. Although it resembles somewhat *N. satura* or a *Volutopsius,* the partitions across its sutures suggest that it is more likely to belong in the *Muricidæ.* "*Chrysodomus*" *diegoënsis* Dall is a *Kelletia.*

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[1] Résultats des Campagnes Scientifiques accomplies sur son Yacht par Albert I, Prince de Monaco, Fasc. 37, Monaco, June 15, 1912; see plates 1, 2, and 3.

Neptunea (Neptunea) satura (Martyn)

Buccinum saturum Martyn, Figures of Nondescript Shells, table 2, pl. 47, 1784.
Buccinum saturnum Martyn, Sherborn, Index Animalium, Sect. 1, p. 871, 1902, error for *saturum*.
Chrysodomus saturus Martyn, Dall, Jour. Wash. Acad. Sci., Vol. 9, no. 1, p. 2, 1919; Bull. 112, U. S. Nat. Mus., p. 97, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 232, pl. 27, figs. 3, 4 (not figs. 1, 2), 1927.

Type specimen: In the Hunter Collection, British Museum, *fide* Oldroyd.

Type locality: King George's Sound.

? Pliocene: Late Pliocene of St. Paul Island, Pribilof group (Dall, 1919).
Recent: Arctic Ocean from Point Barrow to Bering Strait; Plover Bay, south and east to Cape Douglas, Alaska.

Dall reported[1] this species questionably in the Pleistocene on the south side of Herschel Island, Yukon Territory.

Neptunea (Neptunea) satura (Martyn) variety **elatior** (Middendorff)

Tritonium elatior Middendorff, Sib. Reise, p. 225, pl. 10, fig. 3, 1848.
Chrysodomus solutus elatior Middendorff, Dall, Jour. Wash. Acad. Sci., Vol. 9, p. 2, 1919.
Chrysodomus saturus elatior Middendorff, Dall, Bull. 112, U. S. Nat. Mus., p. 97, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 233, 1927.

Pliocene: Late Pliocene of St. George and St. Paul islands, Pribilof group (Dall, 1919).
Recent: Norton Sound south to Unalashka, Alaska (Dall, 1921).

Neptunea (Neptunea) satura (Martyn) variety **tabularis** (Dall)

Chrysodomus saturus Martyn, new variety *tabularis* Dall, Proc. U. S. Nat. Mus., Vol. 56, pp. 323, 324, August 30, 1919.
Chrysodomus saturus tabularis Dall, Jour. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Bull. 112, U. S. Nat. Mus., p. 97, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 236, pl. 12, fig. 6, 1927.

Type specimen: In the U. S. National Museum, No. 31,350.

Type locality: Bering Sea, near Nunivak Island.

Pliocene: Late Pliocene of St. Paul Island, Pribilof group (Dall, 1919).
Recent: Pribilof and Nunivak Islands, Bering Sea (Dall, 1921).

Neptunea (Neptunea) lirata (Martyn)

Buccinum liratus Thomas Martyn, Figures of Nondescript Shells, Vol. 2, table 2, pl. 43, 1784.
Chrysodomus liratus Martyn, Dall, Washington Acad. Sci., "Alaska," Vol. 4, p. 121, 1904, reissued by Smithsonian Institution as the Harriman Alaska Series, Vol. 4, p. 121, 1910; U. S. Nat. Mus., Bull. 112, p. 98, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 237, pl. 11, figs. 1, 3, pl. 20, figs. 1-4, 1927.
Cymatium (*Linatella*) *pacificum* Dall, U. S. Geol. Surv., Prof. Paper 59, pl. 6, fig. 10, 1909; Amer. Jour. Sci., Ser. 5, Vol. 4, p. 312, 1922.
? "*Chrysodomus stantoni* Arnold," Reagan, Trans. Kansas Acad. Sci., Vol. 22, pl. 5, fig. 53, 1909, not of Arnold, *fide* Dall, 1922.
Cymatium pacificum Dall, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93 and table opposite, 1922.

Shell rather large, ventricose, typically with a sloping tabulation on the upper part of the whorls and with strong, square spiral ridges separated by wide interspaces; varying into forms with low sculpture and with incipient interribs.

Miocene: Miocene of Coos Bay, Oregon (as *Cymatium pacificum* Dall, 1909); Empire formation of Coos Bay region, Oregon (Arnold and Hannibal; Howe, as *Cymatium pacificum* Dall); Montesano formation of western Washington (Howe, as *Cymatium pacificum* Dall).
Pliocene: Coos conglomerate of Coos Bay, Oregon (Howe, as *C. pacificum* Dall).
Pleistocene: Douglas Island, Juneau Harbor, Alaska (Dall, 1904).
Recent: Icy Cape, Arctic Ocean, south to Japan on the west, to Puget Sound on the east; and off Point Pinos, California, in 958 fathoms (Dall, 1921).

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[1] Canadian Arctic Expedition, Vol. 8, Pt. A, p. 26A, 1919.

It is surprising that Dall should have redescribed this well-known and very characteristic northern *Neptunea* as a new *Cymatium*. According to Dall, the type of *Cymatium* is *Murex femorale,* which is a grotesque, high-spired, heavy shell with immense varices, not at all similar to *Neptunea lirata* (Martyn).

Mr. George Willett, who has collected extensively in Alaska, says that specimens of this species obtained between southeastern Alaska and Vancouver Island usually have much reduced spiral sculpture, while those occurring from the Alaskan Peninsula westward usually have stronger spiral sculpture.

This is the Pacific analogue of the Atlantic *N. decemcostata* (Say).

Neptunea (**Neptunea**) **lirata** (Martyn) variety **altispira** Gabb

Neptunea altispira Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 44, 45, 71, pl. 14, fig. 2, 1868-9; Cooper, Calif. St. Mining Bureau, Bull. 11, p. 83, 1896; Arnold, in Eldridge and Arnold, U. S. Geol. Survey, Bull. 309, p. 26, 1907; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 395, pl. 31, fig. 6, 1927.

Shell not so prominently shouldered and higher spired than that of the typical variety.

Type specimen: At the Academy of Natural Sciences of Philadelphia.

Type locality: Eagle Prairie, Humboldt County; Pliocene.

Pliocene: Eagle Prairie, Humboldt County (Gabb); "upper part of the Fernando formation northwest of Santa Paula" (Arnold); "Goat Mountain, near mouth of Adams Canyon," Ventura County (Cooper, as Pliocene, probably Las Posas zone, Pleistocene).

Pleistocene: See Pliocene record.

Recent: ?

Neptunea (**Neptunea**) **andersoni** (Martin)

Chrysodomus andersoni Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 186, pl. 19, fig. 4, 1914.

Pliocene: Wildcat formation of Eel River near Scotia, Humboldt County (Martin).

This species is sculptured with rounded spiral cords, uniform in size except on and near the shoulder, where they are coarser and more widely spaced. The variety *hawleyi* has intercalary spirals, which are only slightly smaller than the primaries on the body whorl. The spiral cords of *andersoni* are not widely spaced as in *N. lirata* (Martyn).

Neptunea (**Neptunea**) **andersoni** (Martin) variety **hawleyi** (Carson)

Plate 28, Figures 9*a*, 9*b*, 9*c*

Chrysodomus hawleyi Carson, Bull. So. Calif. Acad. Sci., Vol. 25, pt. 2, p. 55, pl. 2, fig. 3, May 31, 1926.

Type specimen: In the type collection at Stanford University, No. 113.

Type locality: Four miles west of Santa Barbara; upper Pliocene.

Pliocene: Four miles west of Santa Barbara, upper Pliocene (coll. by W. A. Hawley); S. D. S. N. H. loc. 218, upper Pliocene of Sulphur Canyon, east of South Mountain, Ventura County (coll. by Glenn E. Bader).

Pleistocene: "Pliocene" of San Pedro, Los Angeles County (coll. by Delos Arnold).

Variety *hawleyi* differs from typical *andersoni* in the presence of intercalary spirals. On the type of *hawleyi* the intercalary spirals begin to appear on the second whorl from the body whorl and gradually grow in size until they are fully half as large as the primary ribs on the last whorl. The interspaces are flat bottomed. Both the typical form and Carson's variety are strongly shouldered, the latter having a heavy cord on the outer margin of the tabulation, and the next primary below being also accentuated.

Neptunea andersoni variety *hawleyi* appears to be restricted to the cold-water Santa Barbara horizon, uppermost Pliocene, and to the Deadman Island "Pliocene" or Timms Point zone of the lower, cold-water Pleistocene.

Neptunea (Neptunea) venturaensis (Waterfall)

Chrysodomus venturaensis Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 87, pl. 5, figs. 1, 3, pl. 6, figs. 5, 6, April 6, 1929.

Type specimen: In the collection at the University of California, No. 31,424.

Type locality: About one mile above mouth of canyon at head of Kalorama Street, Ventura, California, Pliocene (Waterfall).

Pliocene: In Kalorama Canyon at the type locality, also other localities in the upper Pico formation (Waterfall).

? Pleistocene: Two specimens from the Saugus Pleistocene near Ventura "resemble this form somewhat." (Waterfall.)

The type of this species, as figured by Waterfall (pl. 6, fig. 6), has no tabulation or shoulder on the later whorls, while the paratype (pl. 5, fig. 3) is strongly shouldered. The sculpturing, however, is the same on both specimens, and it is probable that they represent variants of the one species.

The paratype, mentioned above, differs from *N. andersoni* variety *hawleyi* (Carson) in the lack of interspaces between the intercalary and the primary spiral cords, Carson's form having flat interspaces between all the spirals. *N. venturaensis* shows a tendency to have alternate primaries accentuated, producing spiral ribs of three different sizes. This tendency is characteristic of the *Neptuneidæ*. As several of these forms are obviously closely related, more specimens may show that they should be grouped into fewer species.

Neptunea venturaensis (Waterfall) appears to be restricted to the cold-water upper Pliocene and possibly the lower Pleistocene.

Neptunea (Neptunea) leffingwelli (Dall)

Chrysodomus leffingwelli Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 28, pl. 5, fig. 11, January 27, 1920.

Type specimen: In the U. S. National Museum.

Type locality: Colville River, forty miles from the Arctic coast; Pliocene.

Pliocene: At the type locality (Dall).

This species is tabulated and has spiral ridges and widely spaced axial ribs. Dall states that some specimens have the sculpture more or less obsolete.

Neptunea (Neptunea) clarki (Meek)

Chrysodomus clarki Meek, Univ. Calif. Publ. Geol., Vol. 14, p. 417, pl. 79, figs. 1*a*-*b*, November 23, 1923.

Type specimen: In the collection at the University of California, No. 30,593.

Type locality: Skull Cliff beds, Peard Bay, Arctic Alaska; Pleistocene.

Shape like that of *lirata*, but with one large and one small spiral cord per whorl, the larger one nodose.

Pleistocene: Type locality (Meek).

Neptunea (Neptunea) pribiloffensis (Dall)

Chrysodomus pribiloffensis Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 323, August 30, 1919; Journ. Wash. Acad. Sci., Vol. 9, no. 1, p. 2, 1919; U. S. Nat. Mus., Bull. 112, p. 97, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol 2, Pt. 1, p. 231, pl. 21, fig. 4, 1927.

Pliocene: Late Pliocene of St. Paul Island, Pribilof Islands (Dall, 1919).
Recent: Pribilof Islands to Kodiak Island, Alaska, and the Queen Charlotte Islands, British Columbia; also Japan (Dall, 1921).

Neptunea (Neptunea) soluta (Hermann)

Buccinum solutum J. Hermann, Naturforscher, Vol. 16, p. 53, pl. 2, figs. 3, 4, 1781, not of Dillwyn, 1817.
Chrysodomus heros Gray, Proc. Zool. Soc. London, Vol. 18, p. 15, Nov. 12, 1850.
Neptunea despecta Linnæus variety *fornicata* Gray, Tryon, Man. Conch., Vol. 3, p. 116, pl. 45, figs. 251, 252, 253, pl. 46, figs. 255, 256, 1881.
Chrysodomus solutus Hermann, Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Bull. 112, U. S. Nat. Mus., p. 97, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 236, 1927.

Pliocene: Upper Pliocene of St. George and St. Paul Island, Pribilof Islands (Dall, 1919).
Recent: Mackenzie River delta west to Point Barrow and south to Bristol Bay, Bering Sea (Dall, 1921).

Neptunea (Neptunea) soluta (Hermann) variety cordata (Dall)

"*Chrysodomus solutus cordatus* Dall, n. var.," Jour. Wash. Acad. Sci., Vol. 9, no. 1, p. 2, 1919.

Pliocene: Late Pliocene of St. George Island, Pribilof Islands (Dall).

This variety is neither described nor figured in the reference given above, and the present writers have seen nothing to indicate its characters. It is probably a nude name

Neptunea (Neptunea) borealis (Philippi)

Fusus borealis Philippi, Abbild. Beschreib., Vol. 3, p. 118, *Fusus*, pl. 5, fig. 2, 1850.
Chrysodomus borealis Philippi, Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 97, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 231, 1927.

Shell without spiral sculpture, but with prominent nodes on the edge of the tabulation.

Pliocene: Late Pliocene of St. George and St. Paul islands, Pribilof Islands (Dall, 1919).
Recent: Arctic Ocean to Avacha Bay, Kamchatka, the Aleutian Islands, and eastward to the Shumagin Islands, Alaska; 14 to 110 fathoms (Dall, 1921).

Subgenus ANCISTROLEPIS Dall, 1894

Ancistrolepis Dall, Proc. U. S. Nat. Mus., Vol. 17, p. 709, 1894.

Type (by original designation), *Chrysodomus eucosmius* Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 187, 1891, figured in Vol. 17, pl. 29, fig. 7, 1894; + *Ancistrolepis californicus* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 313, 1919; Vol. 66, Art. 17, p. 3, pl. 3, fig. 9, 1925; Pacific coast, Recent.

Shell Buccinoid, with a short, twisted canal; operculum straight, claw shaped, with apical nucleus. (After Dall.)

Ancistrolepis is distinguished from *Neptunea* by its short, wide anterior canal. The columella is strongly incurved in the middle. The type species has prominent, widely-spaced spiral ribs. The same is true of the type of *Beringius* Dall, 1886, though the latter has a higher spire. Perhaps *Ancistrolepis* should be considered a section or synonym of *Beringius*. The species *magna* (Dall), the name of which, if preoccupied, might be replaced by *unica* (Pilsbry), has commonly been referred to this subgenus. However, it does not greatly resemble *eucosmia*, to judge from the figures of the latter, and seems to be more closely related to the other sections of *Sulcosipho*.

Subgenus **SULCOSIPHO** Dall, 1916

Sulcosipho Dall, Proc. Biol. Soc. Washington, Vol. 29, p. 7, January 25, 1916, type *Chrysodomus tabulatus* Baird; Proc. U. S. Nat. Mus., Vol. 54, p. 215, April 5, 1918.

Type (by original designation), *Chrysodomus tabulatus* Baird.

"Shell like *Chrysodomus* but more slender and elongate and with the whorl in front of the suture conspicuously widely sulcate or tabulate, the nucleus inflated and slightly oblique, the color whitish." (Dall, 1918.)

Section Sulcosipho, s. s.

Shell with moderately elongate aperture, produced columella, and well-developed spiral sculpture of numerous spiral cords.

This section is connected with typical *Neptunea* through the strongly tabulated species *postplanata* and *andersoni*. On the other hand, *lawsoni* appears to be a step toward *scotiaensis*, which is much like *pericochlion*, a close relative of the type of *Japelion*.

Neptunea (Sulcosipho) tabulata (Baird)

Chrysodomus tabulatus Baird, Proc. Zool. Soc. London for 1863, p. 66, 1863; Cooper, 7th Ann. Rept., Calif. St. Mineralogist, p. 235, 1888; Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 524, pl. 36, fig. 5, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 228, pl. 7, fig. 6, 1903; Weaver, Univ. Calif. Publ. Geol., Vol. 5, p. 264, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 593, 594, 596, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 189, pl. 20, fig. 2, 1914; Moody, Vol. 10, p. 43, 1916; Dall, U. S. Nat. Mus., Bull. 112, p. 96, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 227, pl. 4, fig. 5, pl. 18, fig. 4, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Chrysodomus bairdi Dall, U. S. Geol. Surv., Prof. Paper 59, p. 43, pl. 2, fig. 4, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 32, 1916; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 240, 1916; Howe, Vol. 14, p. 93, 1922.

Buccinum ? stocki Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 101, pl. 8, figs. 2, 4, 1922.

Type specimens: Of *tabulata*, in the British Museum; of *bairdi*, in the U. S. National Museum.

Type localities: Of *tabulata*, Vancouver Island; of *bairdi*, Coos Bay, Oregon, Empire formation, upper Miocene.

Miocene: Empire formation, upper Miocene, at Coos Bay, Oregon (Dall, as *bairdi*); upper Miocene on Sylvia Creek, western Washington (Weaver, 1916); ? upper San Pablo formation and Santa Margarita formation, upper Miocene of middle California (Weaver, 1909); Bear River, upper Miocene (now thought to be lower Pliocene), Humboldt County, California (Martin, 1916).

Pliocene: Pliocene of Eagle Prairie, Humboldt County; Twelve Mile House, San Mateo County; San Fernando, Los Angeles County (Cooper); Merced formation of San Francisco peninsula and Eel River formation of Eel River (Arnold and Hannibal); upper Wildcat formation, northern California (Howe); Elk River formation north of mouth of Elk River, Port Orford, Oregon (Arnold and Hannibal); Fernando formation of Los Angeles (Moody); Santa Barbara (Cooper); Pico near Ventura (Waterfall).

Pleistocene: "Pliocene" of Deadman Island; lower San Pedro series of Deadman Island and San Pedro; old irrigation ditch north of Ventura (Arnold); Saugus formation near Ventura (Waterfall).

Recent: British Columbia and south to San Diego in 46 to 218 fathoms (Dall, 1921).

This species, the type of *Sulcosipho*, is characterized by the rather uniform spiral ribbing, the prominent tabulation bordered by a raised ridge on the upper part of each whorl, and the rather wide, strong anterior canal. *Chrysodomus bairdi* Dall and "*Buccinum ?*" *stocki* Howe are based upon imperfect, decorticated specimens.

Neptunea (Sulcosipho) tabulata (Baird) variety **colmaensis** (Martin)

Chrysodomus tabulatus var. *colmaensis* Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 188, pl. 20, fig. 1, August 6, 1914; Waterfall, Vol. 18, table opp. p. 78, 1929.

Type specimen: At the University of California, Berkeley.

Type locality: In the bed of Twelve Mile Creek, one and a quarter miles south of Baden Station, San Mateo County; Pliocene.

Pliocene: Merced formation south of San Francisco (Martin).
Pleistocene: Saugus formation, near Ventura (Waterfall).

The variety *colmaensis* is broader in proportion to height than the typical *tabulata.*

Neptunea (? Sulcosipho) postplanata (Dall)

Chrysodomus postplanatus Dall, U. S. Geol. Surv., Prof. Paper 59, p. 43, pl. 7, fig. 5, April 2, 1909; Amer. Jour. Sci., Ser. 5, Vol. 4, p. 309, 1922.

? *Chrysodomus gettysburgensis* Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 190, pl. 3, fig. 26, Nov. 24, 1909; Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 309, 1922.

Type specimens: Of *postplanata,* in the U. S. National Museum, No. 107,781; of *gettysbergensis,* also in the U. S. National Museum.

Type localities: Of *postplanata,* Bogachiel River, one mile above its mouth, Clallam County, Washington, upper Miocene; of *gettysburgensis,* near Gettysburg, Washington, upper Miocene.

Upper Miocene: At the type localities.

From Dall's figure, *N. postplanata* appears to be similar to *N. tabulata* but has a lower spire and broader body whorl. It also lacks the strength of spiral ribbing (perhaps due to erosion) of *tabulata* and its variety *colmaensis.* Dall's type measures 90 mm. in height and 50 mm. in diameter. Perhaps the variety *colmaensis* belongs here. Perhaps it is an older name for *andersoni* or *hawleyi.*

Neptunea (? Sulcosipho) lawsoni (Martin)

Chrysodomus lawsoni Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 184, pl. 19, fig. 1, 1914.

Pliocene: Wildcat formation of Eel River, three-quarters of a mile north of Scotia, Humboldt County, northern California (Martin).

This species is strongly tabulated, like *N. tabulata* (Baird), but is more elongate. It is probably very closely related.

Section JAPELION Dall, 1916

Japelion Dall, Proc. Biol. Soc. Wash., Vol. 29, p. 8, Jan. 25, 1916; Proc. U. S. Nat. Mus., Vol. 54, p. 225, 1918.

Type (by original designation), *Buccinum hirasei* Pilsbry, Proc. Acad. Nat. Sci. Phila. for 1901 (Vol. 53), p. 391, pl. 20, fig. 22, Aug. 16, 1901.

Shell like that of *Sulcosipho* but with the spiral sculpture nearly obsolete, the columella shorter, and the aperture rounded as in *Buccinum.*

Dall stated that the similarity between *pericochlion*[1] (Schrenck) and *hirasei* is a remarkable case of parallel development. However, good specimens in the Golisch Collection at the California Institute of Technology, which agree closely with the figures of these species by Pilsbry, show unmistakably that the two are very closely related. They agree so closely in every particular, except in the length of the columella and aperture, that it does not seem reasonable to attribute their similarity to the coincidences of parallel development. It is even probable that the two forms are varieties of a single species, for in a series of specimens each should be expected to vary somewhat, and it would not require much variation to bridge the gap.

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[1] See *Neptunea pericochlion* Schrenck, Tryon, Man. Conch., Ser. 1, Vol. 3, p. 121, pl. 49, fig. 284, 1881, and *Chrysodomus pericochlion* Schrenck, Pilsbry, Proc. Acad. Nat. Sci. Phila., Vol. 53, p. 391, pl. 20, fig. 23, 1901.

As Tryon apparently observed, the chief difference between *pericochlion* and *tabulata* is in the strength of the sculpture, and the present writers think that this difference is probably not of more than sectional significance. The specimen of *hirasei* in the Golisch Collection has an operculum with an apical nucleus like that of *tabulata*.

Neptunea (Sulcosipho) scotiaensis (Martin)

Chrysodomus scotiaensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 186, pl. 20, figs. *3a-b*, August 6, 1914.

Pliocene: Wildcat series of Eel River, three-quarters of a mile north of Scotia, Humboldt County (Martin).

This species is likewise closely similar in general appearance to *tabulata*.

Section CLINOPEGMA, new section

Type: Buccinum unicum Pilsbry.

Shell much like that of *Japetion* but with the posterior tabulation sloping and marked on the angle by a ridge; sometimes the tabulation divided into two concave parts by another ridge, like the one on the outer angle.

Ancistrolepis might be thought of as a somewhat similar development, with the angulations and ridges continuing all the way down the side of the whorl; but the connection between *Ancistrolepis* and *Clinopegma* does not seem as real as the connection between *Japelion* or *Sulcosipho* and *Clinopegma*. *Ancistrolepis* seems more like the young of such species as *N. lirata*, or perhaps a degenerate relative. On the other hand, *Japelion* and *Clinopegma* grade into *Colus* by the loss of the angulation or by appressing it to the suture.

Neptunea (Sulcosipho) magna (Dall)

Chrysodomus (*Ancistrolepis*) *magnus* Dall, Proc. U. S. Nat. Mus., Vol. 17, p. 709, pl. 29, fig. 5, 1895.
Buccinum unicum Pilsbry, Proc. Acad. Nat. Sci. Phila., Vol. 57 (for 1905), p. 102, April 8, 1905; Vol. 59 (for 1907), p. 244, pl. 20, fig. 7, 1907.
Chrysodomus (*Ancistrolepis*) *unicus* Pilsbry, Dall, Smithsonian Misc. Coll., Vol. 50, Pt. 2, p. 157, 1907.
Ancistrolepis magnus Dall, Bull. 112, U. S. Nat. Mus., p. 92, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 203, pl. 25, fig. 5, 1927.

Recent: Okhotsk and Bering seas (Dall); Japan (Pilsbry).

The typical form of this species has a shorter spire than the variety *stantoni*, and the same seems to be true to a less extent of the form described by Pilsbry. However, a specimen in the Oldroyd Collection at Stanford University from Japan has a higher spire than the Recent forms that have been figured. This specimen should probably be assigned to the variety *damon* (Dall),[1] which may be an older name for the variety *stantoni*. The variety *damon* has, if anything, a higher spire than *stantoni*. The form *decora*,[2] more recently described by Dall, seems to be based on a young specimen from the Japan Sea with stronger spiral sculpture. The oldest name of all that has been applied to a form with the general appearance of *Clinopegma* is *Buccinum viridum* Dall.[1] This name is based upon a small, short, low-spired, apparently immature individual, like *magna* but with a *Buccinum* operculum. It seems probable that this species belongs to the group also, in spite of its operculum. It might even be a young variant of *magna*. The many cases of so-called parallel development between the *Neptuneidæ* and the *Buccinidæ* provide strong evidence that the separation of the *Neptuneidæ* from the *Buccinidæ* is artificial. This separation is based upon the pure assumption that opercula are of primary importance in classification.

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[1] *Chrysodomus* (*Ancistrolepis*) *damon* Dall, Smithsonian Misc. Coll., Vol. 50, p. 157, 1907; *Ancistrolepis damon* Dall, Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 3, pl. 34, fig. 5, 1925.

[2] *Ancistrolepis decora* Dall, Proc. U. S. Nat. Mus., Vol. 66, Art. 17, p. 3, pl. 35, fig. 10, 1925.

Neptunea (**Sulcosipho**) **magna** (Dall) variety **stantoni** (Arnold)

Chrysodomus stantoni Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 386, pl. 37, fig. 4, August 8, 1908; not "*Chrysodomus stantoni* Arnold," Reagan, 1909, *fide* Dall, Amer. Jour. Sci., Ser. 5, Vol. 4, p. 312, 1922.

Shell large, whorls ventricose, with a strongly sulcate suture and a sloping tabulation bordered by a spiral ridge; base of body whorl with a few faint, wide spiral cords. Altitude, 90 mm. (incomplete specimen); width, 45 mm.

Type specimen: In the U. S. National Museum, No. 165,475.

Type locality: Purisima Rock, seven-eighths of a mile east of Año Nuevo Point, San Mateo County; Purisima formation, Pliocene.

Pliocene: At the type locality; sea cliffs between mouths of Tunitas and Pescadero Creeks, Purisima formation; near mouth of Año Nuevo Creek, San Mateo County; sea cliff west of Capitola, Santa Cruz County, Merced formation (Arnold).

The variety is so similar to Recent specimens of *unica* that it can be distinguished only by its greater size and the subdued condition of the spiral sculpture on the base of the body whorl (which may be due to erosion).

Subgenus **COLUS** Bolten, 1798

Colus Bolten, Mus. Boltenianum, p. 117, 1798; Dall, Journ. Conch., Vol. 11, no. 10, p. 294, 1906; Proc. U. S. Nat. Mus., Vol. 54, p. 216, 1918.

Tritonofusus (Beck ?), Deutscher Naturforscher und Aerzte, Amtlicher Bericht über die 24 Versammlung in Kiel, September, 1846, p. 114, 1847; Herrmannsen, Indicis Gen. Malac., Vol. 2, p. 611, 1849; Dall, Proc. U. S. Nat. Mus., Vol. 24, pp. 520, 522, 1902.

Sipho Klein, of various authors.

Type (by subsequent designation, Dall, 1906), *Murex islandicus* Gmelin, Syst. Nat., Ed. 13, p. 3555, 1790, = ? *Murex islandicus* G. Mohr, Island Nat., p. 136, 1786; = *Murex corneus* Linnæus, Syst. Nat., Ed. 10, p. 754, 1758; Ed. 12, p. 1224, 1767; Gmelin, Ed. 13, p. 3552, 1790; *Fusus islandicus* Chemnitz, Neues Syst. Conch. Cab., Vol. 4, pl. 141, figs. 1312, 1313, 1780; *Colus islandicus* Bolten, Mus. Boltenianum, p. 117, 1798; *Fusus islandicus* Lamarck, Ency. Méth., pl. 429, fig. 2, 1816; Crouch, Lamk. Conch., pl. 17, fig. 8, 1827; *Murex corneus*, Dillwyn, Cat., Vol. 2, p. 723, 1817; Wood, Ind. Test., pl. 27, fig. 107, 1818; *Fusus islandicus* Martini, Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, p. 37, pl. 7, figs. 2 (not pl. 15, figs. 2), 1840; *Fusus corneus* Linnæus, Deshayes in Lamarck, Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 9, p. 450, 1843; Recent, Iceland to Ireland; much like *stimpsoni* of the east coast of North America.

Shell like that of *Neptunea antiqua* but usually smaller, more slender, with less inflated whorls and shorter aperture.

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[1] *Buccinum viridum* Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 320, pl. 6, fig. 9, 1889; also figured by Keep, West Amer. Shells, p. 172, fig. 165, 1904.

Deshayes remarks that the type of this subgenus is closely related to *N. antiqua.* It is a large northern shell, large for the group. Some of its smaller relatives go southward in deep water. They are classified in the section *Anomalosipho.* Perhaps further research will disclose older names for some of the sections in this family.

Neptunea (Colus) eurekaensis (Martin)

Chrysodomus eurekaensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 185, pl. 21, figs. 1*a-b*, 1914.

Shell elongate, body whorl smooth, upper whorls of spire with small spiral cords; a slight constriction below the suture. Type specimen, 86 mm. long and 45 mm. in diameter.

Type specimen: At the University of California.

Type locality: Near Scotia, Humboldt County, northern California.

Pliocene: At the type locality.

This species is like *"Chrysodomus" ithius* Dall but larger.

Neptunea (Colus) purisimaensis (Martin)

Chrysodomus purisimaensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 187, pl. 19, fig. 2, 1914.

Shell elongate, high spired, not tabulated. Type specimen, 100 mm. in length (incomplete) and 50 mm. in diameter.

Type specimen: At the University of California.

Type locality: Año Nuevo Bay, San Mateo County; Pliocene.

Pliocene: Purisima formation of Año Nuevo Bay, San Mateo County (Martin).

This species is similar to the last.

Section ANOMALOSIPHO Dautzenberg and Fischer, 1912

Anomalosipho Dautzenberg and Fischer, Rés. Camp Sci. Albert 1, Prince de Monaco, Vol. 37, p. 99, 1912; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 218, 1918.

Latisipho Dall, Proc. Biol. Soc. Washington, Vol. 29, p. 7, 1916; Proc. U. S. Nat. Mus., Vol. 54, p. 217, 1918, type (by original designation), *Chrysodomus hypolispus* Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 188, 1891; Vol. 17, pl. 27, fig. 1, 1894.

Type (*fide* Dall, 1916, 1918), *Sipho verkrüzeni* Dautzenberg and Fischer (not Kobelt), = *Colus dautzenbergii* Dall.

Shell smaller and more delicate, sometimes with a relatively shorter columella and more rounded aperture.

Dall's section has a more curving columella and anterior canal. In spite of Dall's opinion, perhaps the true *verkrüzeni* should be taken as type of *Anomalosipho.* It probably belongs to the same group but seems to lack the spiral grooves.

Neptunea (Colus) halibrecta (Dall)

Chrysodomus (*Sipho*) *halibrectus* Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 188, 1891; Vol. 17, p. 708, pl. 29, fig. 9, 1894.

Chrysodomus halibrectus Dall, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 239, 1916.

Colus (*Latisipho*) *halibrectus* Dall, U. S. Nat. Mus., Bull. 112, p. 96, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 226, pl. 25, fig. 9, 1927.

Shell elongate, with fine spiral striæ; length 35 mm., breadth, 13.5 mm.

Pliocene: Upper division of Wildcat series, northern California (Martin).
Recent: Southern Bering Sea, near Unalaska Island, 351 to 399 fathoms (Dall, 1921).

Neptunea (Colus) jordani (Dall)

Plate 28, Figure 11

Tritonofusus jordani Dall, Proc. U. S. Nat. Mus., Vol. 45, p. 588, June 11, 1913.
Colus (*Latisipho*) *jordani* Dall, Bull. 112, U. S. Nat. Mus., p. 96, pl. 12, fig. 7, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 225, pl. 16, fig. 5, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Sucia Island, Gulf of Georgia; Recent.

Pleistocene: Elk River formation, north of the mouth of Elk River, Port Orford, Oregon (specimen in the collection at Stanford University).
Recent: Bering Sea, 70 to 100 fathoms; British Columbia, 67 to 142 fathoms; Monterey Bay, California, 633 fathoms.

This species recalls *Buccinum strigillatum* but is more elongate, with a different aperture.

Neptunea (Colus) riversi (Martin)

Tritonofusus riversi Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 190, pl. 21, fig. 2, August 6, 1914.
Colus (*Latisipho*) *riversi* Martin, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 82, 1929.

Shell like that of *jordani* but with a longer anterior canal.

Type specimen: At the California Academy of Sciences.

Type locality: Timms Point, San Pedro, Los Angeles County; Pleistocene.

Pliocene: "Lower Pico" near Ventura, middle Pliocene (Waterfall).
Pleistocene: Timms Point, San Pedro, Los Angeles County (Martin).

Neptunea (Colus) aphela (Dall)

Chrysodomus aphelus Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 323, pl. 6, fig. 7, 1889; Rivers, Bull. So. Calif. Acad. Sci., Vol. 3, no. 5, p. 71, May 24, 1904.
Colus (*Latisipho*) *aphelus* Dall, Bull. 112, U. S. Nat. Mus., p. 96, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 225, pl. 13, fig. 3, 1927.

Type locality: In 414 fathoms off the coast of Santa Barbara County, California.

? Lower Pleistocene: "Pliocene" of Santa Monica (Rivers).
Recent: Chirikoff Island, Alaska, to San Diego, California, 290 to 626 fathoms (Dall, 1921).

Neptunea (Colus) merriami (Rivers)

Chrysodomus merriami Rivers, Bull. So. Calif. Acad. Sci., Vol. 3, no. 5, p. 70, May 24, 1904.

"Shell bucciniform; whorls eight; nucleus eroded; incremental and fine lines appear as soon as growth begins which increase in regular ratio until the body whorl show ridges and appressed lines that gage six to a mm. Apex not depressed as it gages 20 mm.; the whorls are strongly rounded; sutures deeply impressed; bodywhorl 25 mm. long, much inflated; outer lip not thickened but has a bulging inflation turning inwards; the edge being entire. The columnella being hid in the matrix but from several fragmentary examples; the columnella is short, twisted; channel wide; aperture very wide.

"This shell was found in the same deposit as *C. aphelus* Dall and *C. griseus* Dall.

"Geological formation: Pliocenl; Santa Monica Range." (Rivers.—The spelling and punctuation are as in the original, which appears to have been printed from rough notes and not proof-read.)

Type locality: Rivers describes the locality as follows:

"The fossils occur in a silty formation in which remains of marine and terrestrial flora abound. The elevation from sea level of these strata varies from a few feet up to seventy or a hundred feet above. The height or depth of these strata carries no geological value but it is their position and what they contain that yield their natural worth; these strata dip strongly to the southwest at various angles and in places tilted to the perpendicular. These fossils therefore may have enjoyed at one time a depth of 414 fathoms, particularly so as the deposits dip under a hundred feet of nearly horizontal Pleistocene."

? Lower Pleistocene: "Pliocene" of the Santa Monica Range (Rivers).

This species is probably represented in the living fauna, but it is difficult to determine without material what it is.

Section PLICIFUSUS Dall, 1902

Plicifusus Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 523, 1902, Vol. 54, p. 219, 1918.

Parasipho Dautzenberg and Fischer, Rés. Camp. Sci., Albert I, Prince de Monaco, Pt. 37, pp. 82, 100, "type *Sipho kröyeri* Möller," 1912.

Type (by original designation), *Fusus kröyeri* Möller, Naturhist. Tidsskrift, Vol. 4, Pt. 1, p. 88, 1842; Index Moll. Groenl., p. 15, 1842; figured by Dautzenberg and Fischer, *op. cit.*, pl. 4, figs. 6, 7, 1912, also by Tryon, Man. Conch., Ser. 1, Vol. 3, p. 130, pl. 53, figs. 233-236, 1881.

Shell solid, usually with developed axial ribs and more feeble spiral sculpture, the aperture expanded and with a wide insinuation behind on the outer lip; canal usually short and wide, nearly straight. (After Dall, 1902.)

The type of *Plicifusus* is a circumboreal species which extends west in the Arctic Ocean to Point Barrow. *Buccinum cretaceus* Reeve may be a synonym. *N. kröyeri* (Möller) is very similar to the type of *Colus* except that it has axial ribs on the early whorls.

Neptunea (Colus) arctica (Philippi)

Fusus arcticus Philippi, Abbild. Beschreib. Conchyl., Vol. 3, p. 119, pl. 5, fig. 5, 1850.

Plicifusus arcticus Philippi, Dall, Journ. Washington Acad. Sci., Vol. 9, p. 2, 1919; U. S. Nat. Mus., Bull. 112, p. 93, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 207, 1927.

Shell fusiform, with numerous small axial plications.

Pliocene: Late Pliocene of St. George Island, Pribilof Islands (Dall, 1919).

Recent: Arctic Ocean, Bering Sea, Aleutians to Shumagin Islands, Alaska; circumboreal.

Section LATIFUSUS Dall, 1916

Latifusus Dall, Proc. Biol. Soc. Wash., Vol. 29, p. 8, 1916.

Type (by original designation), *Chrysodomus griseus* Dall.

Dall says of this section that it is the Buccinoid phase of *Plicifusus,* as *Latisipho* is of *Colus.*

Neptunea (Colus) grisea (Dall)

Chrysodomus griseus Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 322, pl. 5, fig. 6, 1889; Rivers, Bull. So. Calif. Acad. Sci., Vol. 3, no. 5, p. 72, May 24, 1904.

Plicifusus (*Retifusus*) *griseus* Dall, Bull. 112, U. S. Nat. Mus., p. 93, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 210, 1927.

Type locality: With *N. aphela.*

? Lower Pleistocene: "Pliocene" of Santa Monica Range (Rivers).

Recent: Bering Sea (27 fathoms) to San Diego, California (636 fathoms), (Dall, 1921).

In spite of the differences, the similarity of the distribution and the association of this form with *aphela* suggest that it is but a variety of that species, just as the type of

Plicifusus may be a variety of the type of *Colus*. The subdivisions of *Colus* are still very artificial, and a number of older names, such as those of Mörch and Cossmann, need to be given more serious attention. Probably some of Dall's very recent names will fall into synonymy.

Genus EXILIOIDEA, new genus

"*Exilia* Conrad" of Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 221, 1918, in part; of various Pacific coast collectors and authors; not of Conrad, Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 4, p. 291, 1860; nor of Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 418, 1927, a genus of *Turridæ;* nor *Exilia* Mulsant, 1863, Coleoptera.

Type, Chrysodomus rectirostris Carpenter.

Shell elongate, very slender, with numerous whorls, chrysodomoid nucleus, and a straight canal; periostracum conspicuous, polished; sculpture of numerous fine flexuous axial ribs and spiral striation; aperture small, simple, not lirate within, outer lip thin, sharp, not reflected; inner lip and pillar smooth, without plications or denticles of any sort; operculum long, slightly arcuate, with apical nucleus. (Dall, 1918, description of "*Exilia*.")

Stewart (1927) has pointed out that the type of *Exilia* Conrad has a small anal notch, which suggests that it belongs to the *Turridæ*. The Pacific coast Pleistocene to Recent species which Dall called *Exilia rectirostris* (Carpenter) has no indication of a Turrid notch and is probably not related to typical *Exilia* of the Texas Eocene. We have therefore proposed for the Pacific "*Exilia*" *rectirostris* the new generic name *Exilioidea*, and have placed it tentatively in the *Neptuneidæ*, admitting, however, that it appears out of place in that family.

Exilioidea rectirostris (Carpenter)

Plate 28, Figure 5

Chrysodomus rectirostris Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 603 (nude name), p. 664 (brief description), 1864; Proc. Acad. Nat. Sci. Phila., for 1865, p. 64, August, 1865; Tryon, Man. Conch., Ser. 1, Vol. 2, p. 131, pl. 53, fig. 348, 1881; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 228, pl. 7, fig. 7, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 221, 1918.

Tritonofusus (*Plicifusus*) *rectirostris* Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 525, pl. 34, fig. 2, 1902.

Exilia rectirostris Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 92, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 90, pl. 19, fig. 2, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 206, pl. 6, fig. 7, pl. 28, fig. 2, 1927.

Type specimen: In the U. S. National Museum, No. 4815.

Type locality: Puget Sound; Recent.

Pleistocene: "Rare in the Pliocene and lower San Pedro series at Deadman Island, and in the upper San Pedro series at Crawfish George's" (Arnold).

Recent: Behm Canal, Alaska, to Cape San Quintin, Lower California, Mexico (Dall, 1921).

The series of specimens of this species which we have examined shows no indication of an anal notch such as is characteristic of the *Turridæ*, to which the typical *Exilia* probably belongs.[1] As there seems to be no evidence of close relationship between the type of *Exilia*, which is an Eocene shell of Texas, and the west American *"Exilia" rectirostris*, aside from a superficial resemblance, we have placed the latter in the new genus *Exilioidea*.

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[1] It is true that some forms belonging to the *Turridæ* show very faint anal notches or even none at all, such as *Daphnella*, *Bela*, *Mitromorpha*, some species of *Lora*, etc., and the genus *Priscofusus*, doubtfully referred to the *Turridæ*, has only a broad bending back of the growth lines on the outer lip, after the analogy of some species of *Surculites*. The case of *Priscofusus* is similar to that of *Exilioidea*, and for the time being the family relationships must remain uncertain. The type of *Exilia* (type by monotypy, *E. pergracilis* Conrad, Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 4, p. 291, pl. 47, fig. 34, 1860, also figured by Harris, Bulla. Amer. Paleo., Vol. 1, p. 204, pl. 9, fig. 1, 1896; Eocene of Texas) has, according to Stewart, "a faint notch in the outer lip. . . which is probably a shallow anal sulcus." The true *Exilia* has a slender, elongate shell, consisting of numerous whorls; the anterior canal is long and straight; and the columella is smooth. The two oblique columellar plaits attributed to it by Cossmann are thought to have been introduced as an error caused by a specific misidentification. *Exilia*, because of its comparatively early date, 1860, should have been included in the treatment of the *Turridæ;* but, probably like a number of other names, it was overlooked because it had been assigned to another family. It probably belongs in the table close to *Pleurofusia* or *Moniliopsis*.

Recent specimens of this species show variation in the strength of the axial ribs, but all are rather uniform in shape. Mr. George Willett, of the Los Angeles Museum, collected this species by dredging in 50 fathoms off Forrester Island, Alaska, but did not find it in the straits.

Genus LIOMESUS Stimpson, 1865

Liomesus Stimpson, Canadian Naturalist and Geologist, New Series, Vol. 2, p. 366, October, 1865, type *Buccinum dalei;* Dall, Bull. Mus. Comp. Zool., Vol. 18, pt. 2, p. 176, 1889; Cossmann, Ann. Soc. Roy. Malac. Belgique, Vol. 24 (Ser. 4, Vol. 4), p. 141, 1889.

Buccinopsis Jeffries, Brit. Conch., Vol. 4, p. 297, 1867.

Type (by original designation), *Buccinum dalei* J. de C. Sowerby, Mineral Conch. Gt. Brit., Vol. 5, p. 139, pl. 486, figs. 1, 2, 1829; figured also by Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 408, pl. 109, figs. 1, 2, 1851; Recent, coasts of Greenland to British Isles; also Pliocene of the Coralline Crag and Red Crag of England.

Shell of moderate size, bucciniform; with spiral striations or threads; pillar short, twisted; outer lip thickened, not reflected; operculum with an apical nucleus; periostracum conspicuous.

This genus is similar to *Buccinum* but has an operculum with an apical nucleus.

Liomesus ovoides (Middendorff) variety canaliculatus (Dall)

Buccinopsis canaliculata Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 252, Feb. 26, 1874.

Buccinopsis canaliculatus Dall, Kobelt, Martini and Chemnitz, Conch. Cab., Ed. 2, Vol. 3, *Buccinum*, p. 102, pl. 88, fig. 2, 1883.

Liomesus canaliculatus Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 531, pl. 38, fig. 2, 1902; Harmer, Mon. Palæo. Soc., Vol. 67, Plio. Moll. Gt. Brit., Vol. 1, p. 115, 1914.

Liomesus ovoides canaliculatus Dall, Bull. 112, U. S. Nat. Mus., p. 91, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 198, pl. 2, fig. 23, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Cape Espenberg, Arctic Ocean.

Pliocene: Butleyan Crag, lower part of upper Pliocene of England; Pliocene of Iceland (Harmer); etc.
Recent: Icy Cape, Arctic Ocean, to Shumagin Islands.

This is a compact species with a very short, wide anterior canal and sculpture of fine spiral threads and smaller intercalaries. The type is about 33 mm. in height and 20 mm. in width.

The species *L. ovoides* (Middendorff) 1848, occurs in the Okhotsk Sea and in the Pleistocene of Yesso, Hokkaido, Japan.

Liomesus sulculatus Dall

Liomesus sulculatus Dall, U. S. Geol. Surv., Prof. Paper 59, p. 44, pl. 5, figs. 2, 3, April 2, 1909; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 238, 1916; Howe, Vol. 14, table opposite p. 93, 1922.

? *"Monoceros engonatum* Conrad," Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 220, pl. 6, fig. 55, November 24, 1909, not of Conrad, *fide* Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 313, 1922.

Liomesus "sulcatus" Dall, Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 32, 1916.

Shell with about fifteen uniform, flat-topped spiral ridges having equal or wider, not channeled interspaces, the whole surface marked with very fine microscopic spiral striation.

Type specimen: In the U. S. National Museum, No. 153,904.

Type locality: Coos Bay, Oregon; Empire formation, upper Miocene.

Miocene: Empire formation of Coos Bay, Oregon (Dall, 1909); Montesano formation of western Washington, upper Miocene (Weaver); mouth of Maxfield Creek, Quillayute, Washington, as "Pliocene" (Reagan).
Pliocene: Coos conglomerate of Coos Bay, Oregon (Howe); lower part of the Wildcat formation, northern California (Martin).

Nomland (Univ. Calif. Publ. Geol., Vol. 10, p. 301, 1917) reported an unidentifiable species of *Liomesus* in the Santa Margarita formation north of Coalinga.

Family BUCCINIDAE

Genus BUCCINUM Linnæus, 1758

Buccinum Linnæus, Syst. Nat., Ed. 10, p. 734, 1758, includes *B. undatum* L.; Montfort, Conch. Syst., Vol. 2, pp. 462-464 and figure, 1810, type *B. undatum;* Children, Quart. Jour. Sci., Lit., and the Arts, Vol. 16, p. 59, pl. 5, fig. 195, October, 1823, type *Buccinum undatum* Linn.; Tryon, Man. Conch., Ser. 1, Vol. 3, p. 100, 1881; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 144, 1901.

Type (by subsequent designation, Montfort, 1810), *Buccinum undatum* Linnæus, figured by Reeve, Conch. Icon., Vol. 3, *Buccinum,* pl. 1, fig. 3, 1846; north Atlantic.

Shell ovate or oblong, covered with a horny epidermis; spire elevated, apex acute; aperture large, oval, emarginate in front; canal wide, very short, or a mere oblique truncation of the base of the aperture; columella smooth; inner lip expanded; outer lip usually thin, smooth internally; operculum ovate, nucleus small near the outer front edge. (Tryon.)

The present authors have made no attempt to work out the synonymy of this genus nor of any of the species. There are too many specific names, but lack of some of the literature bearing on this group and an insufficient series of specimens make it impracticable to attempt to change the present status, unsatisfactory as it is.

The family *Neptuneidæ* is distinguished principally by its differently formed operculum. *Liomesus,* for instance, would otherwise be assigned to the *Buccinidæ.* It is questionable whether opercula are reliable for separating families.

Buccinum glaciale Linnæus

Buccinum glaciale Linnæus, Fauna Suecica, Ed. 2, p. 523, 1761; Syst. Nat., Ed. 12, p. 1204, 1767; Reeve, Conch. Icon., Vol. 3, *Buccinum,* pl. 3, fig. 18, 1846; Tryon, Man. Conch., Ser. 1, Vol. 3, p. 185, pl. 76, fig. 345, 1881; Dall, U. S. Nat. Mus., Bull. 112, p. 98, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 238, 1927.
Buccinum glaciale "Dall," Meek, Univ. Calif. Publ. Geol., Vol. 14, p. 415, 1923.

Shell subulately ovate, sutures of the spire deep, whorls somewhat flattened, longitudinally obliquely plicated, transversely two or three keeled, interstices between the keels regularly, elevately striated; aperture short, lip conspicuously effused; dull yellowish brown, lip white. Size about 60 mm. in length and 35 mm. in width. (After Reeve.)

Type specimen: In the collection of the Linnæan Society of London.

Type locality: Northern Sea, *fide* Oldroyd.

Pleistocene: Peard Bay, Alaska (Meek).
Recent: Arctic Ocean to Fuca Strait; circumboreal (Dall, 1921).

This species has a number of synonyms that have not been included above. The genus is in need of a critical review, which would result in eliminating many useless names.

Buccinum glaciale Linnæus variety **parallelum** Dall

Tritonium corinatum Dunker, Novit. Conch. Moll. Marina, p. 1, pl. 2, figs. 3, 4, 1858; not *Buccinum carinatum* Gmelin, 1792, nor of Turton, 1819.
Buccinum angulosum Mörch, in Dunker, Novit. Conch. Moll. Marina, pl. 2, figs. 3, 4, explanation on plate, *fide* Dall, 1918; not *B. angulosum* Gray, 1839.
Buccinum glaciale var. *parallelum* Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 231, 1918; Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; U. S. Nat. Mus., Bull. 112, p. 98, pl. 8, fig. 10, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 239, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Bering Sea.

Pliocene: "Late Pliocene" of St. George Island, Pribilof Islands (Dall, 1919).
Recent: Pribilof and Aleutian islands to Cook's Inlet; also Kurile Islands.

This variety is so close to the typical variety that it hardly deserves separate recognition.

Buccinum tenue Gray

Buccinum tenue Gray, Zool. Beechey's Voyage, p. 128, pl. 36, fig. 19, 1839; Dall, Exped. to Point Barrow, p. 179, 1885; Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Canadian Arctic Exped., Vol. 8, Pt. A, p. 26A, 1919; U. S. Nat. Mus., Bull. 112, p. 98, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 240, 1927.

Type locality: Icy Cape, Arctic, *fide* Oldroyd.

Pliocene: "Late Pliocene" of St. George Island, Pribilof group (Dall, 1919).
Pleistocene: South side of Herschel Island, Yukon Territory, "fragment" (Dall, 1919, p. 26A).
Recent: Arctic Ocean southward to Kamchatka to the west, the Aleutian Islands to the east, and thence to Fuca Strait; circumboreal (Dall, 1921).

Buccinum polare Gray

Buccinum polare Gray, Zool. Beechey's Voy., p. 128, 1839; Dall, U. S. Nat. Mus., Bull. 112, p. 99, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 243, 1927.
Buccinum polore "Dall," Meek, Univ. Calif. Publ. Geol., Vol. 14, p. 415, 1923.

Type locality: Icy Cape, Arctic; *fide* Oldroyd.

Pleistocene: Peard Bay, Alaska (Meek).
Recent: Arctic Ocean and south in Bering Sea to Avacha Bay, Kamchatka, on the west, and to Alaska Peninsula on the east (Dall).

Buccinum plectrum Stimpson

Buccinum plectrum Stimpson, Canadian Naturalist and Geologist, Ser. 2, Vol. 2, p. 374, 1865; Kobelt, Conch. Cab., Ed. 2, pl. 91, fig. 2, 1883; Newcombe, Nautilus, Vol. 10, p. 17, 1896; Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896; Proc. U. S. Nat. Mus., Vol. 24, p. 519, pl. 37, fig. 5, 1902; U. S. Nat. Mus., Bull. 112, p. 98, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 239, pl. 5, fig. 5, 1927.

Miocene: "Miocene" of St. Paul Island; Unalaska; Unga Island (Dall, 1896).
Recent: Point Barrow, Arctic Ocean, south to Puget Sound; circumboreal (Dall, 1921).

This is a handsome species with spiral striations and wavy, generally protractive, axial folds.

Buccinum angulosum Gray variety **normale** Dall

Buccinum normale Dall, Rept. Exped. to Pt. Barrow, p. 179, pl. 3, fig. 1, 1885; U. S. Nat. Mus., Bull. 112, p. 100, 1921; Meek, Univ. Calif. Publ. Geol., Vol. 14, p. 415, 1923.
Buccinum angulosum normale Dall, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 255, pl. 5, fig. 6, 1927.

Type specimen: In the U. S. National Museum, No. 40,966-7.

Type locality: Cape Smythe.

Pleistocene: Peard Bay, Alaska (Meek).
Recent: Arctic Ocean from Point Barrow to Kotzebue Sound (Dall, 1921).

The normal variety lacks the carina of the typical variety.[1]

Buccinum strigillatum Dall

Buccinum strigillatum Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 186, 1891; Vol. 17, p. 706, pl. 17, fig. 9, 1894; U. S. Nat. Mus., Bull. 112, p. 100, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 253, pl. 15, fig. 7, 1927.
Buccinum saundersi Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 183, pl. 21, fig. 5, 1914.

Type specimens: Of *strigillatum,* in the U. S. National Museum; of *saundersi,* in the collection at the University of California.

Type localities: Of *strigillatum,* off Guadalupe Island, Lower California, Mexico, in 167 fathoms; of *saundersi,* in the upper portion of the Wildcat series two miles south of Centerville, Humboldt County, California, upper Pliocene.

Pliocene: At the type locality of *saundersi.*
Recent: Fuca Strait, in 178 fathoms, to San Diego, in 822 fathoms, and to Guadalupe Island, Lower California, Mexico (Dall, 1921).

Buccinum tenebrosum Hancock

Buccinum tenebrosum Hancock, Ann. Mag. Nat. Hist., Vol. 18, p. 327, 1846; Dall, U. S. Nat. Mus., Bull. 112, p. 101, 1921, as questionable variety; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 259, 1927.
Buccinum ? bogaehielii Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 218, pl. 5, figs. 51*a-b*, Nov. 24, 1909; Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 312, 1922.

Type specimens: Of *tenebrosum,* location unknown to the writers; of *bogachielii,* in the U. S. National Museum.

Type localities: Of *tenebrosum,* west coast of Davis Strait; of *bogachielii,* Quillayute formation of Washington, upper Miocene.

Miocene: Quillayute formation, near Quillayute River, Washington (Reagan).
Recent: Bering Strait; circumboreal.

Dall (1922) suggested that Reagan's species is probably conspecific with *B. tenebrosum.* According to Arnold and Hannibal,[2] the fossils Reagan reported as Pliocene from the Quillayute formation are redeposited Empire formation species and therefore are Miocene in age instead of Pliocene.

Buccinum jordani Hertlein

Buccinum jordani Hertlein, Bull. So. Calif. Acad. Sci., Vol. 24, pt. 2, p. 41, pl. 3, fig. 3, 1925.

Type specimen: In the type collection at Stanford University.

Type locality: Eight miles up Sylvia Creek, Montesano, Washington.

Miocene: At the type locality (Hertlein).

This form lacks axial sculpture, but has spiral sculpture consisting of fine revolving straps. It has somewhat the shape of *B. polare* Gray, but the sutures are less depressed.

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[1] *Buccinum angulosum* Gray, Zool. Beechey's Voy., p. 127, pl. 36, fig. 6, 1839; also figured by Oldroyd, *op. cit.*, pl. 5, figs. 1, 2, 3, pl. 17, figs. 9, 10, 1927. *Buccinum glaciole parallelum* Dall and *Buccinum bæri* Middendorff variety *mörchianum* Fischer (Journ. de Conchyl., Vol. 7, p. 299, pl. 10, fig. 2, 1858, figures reproduced by Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, pl. 27, figs. 1, 2, not figs. 3, 4, 1927) appear more like *angulosum* Gray, as figured by Oldroyd, than does Dall's variety.

[2] Proc. Amer. Philos. Soc., Vol. 52, p. 604, 1913.

Family NASSARIIDAE

Genus NASSARIUS Duméril, 1805

Arcularia Martini, Neues Syst. Conch. Cab., Vol. 2, p. 18, 1771.

Nassarius Duméril, Zool. Analytique, p. 166, 1806, genus without species; Froriep's translation, p. 167, 1806, only species added, *Buccinum arcularia, fide* Iredale, Proc. Malac. Soc. London, Vol. 12, pp. 80, 81, 82, 1916.

Arcularia Link, Beschr. Nat. Samml. Univ. Rostock, p. 126, 1807.

? *Eione* Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 171, 1826; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 414, Apr. 18, 1847.

"*Nassa* Martini," H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 116, 1853.

Type (by monotypy), *Buccinum arcularia* Linnæus, Syst. Nat., Ed. 10, p. 737, 1758; figured by Reeve, Conch. Icon., Vol. 8, *Nassa*, pl. 4, figs. 25*a*, 25*b*, 1853, Philippine Islands; Recent.

Shell rather ovate, spire produced; sculpture variable; aperture ovate; anterior canal abruptly truncated and deeply notched; a basal constriction on the exterior of the body whorl usually prominent.

Arcularia was used by Martini as a section of *Galeodes* or *Semicassis*, which, according to Martini, is a subgenus of *Cassis*. In his list of species (pages 89 to 94), he included *Arcularia major* Martini, stated to be equivalent to *Buccinum arcularia* Linnæus, which thus becomes the type by absolute tautonomy. However, Martini's work is not consistently binomial and is generally disregarded for nomenclatorial purposes.

As stated by Woodring, there is no direct proof that *Nassarius* Duméril was proposed as a substitute for *Nassa* Lamarck. Froriep assigned the single species *Buccinum arcularia* Linnæus to *Nassarius*, which thus becomes the type of the genus by monotypy. *Eione* Risso has for type "*Nassa*" *gibbosula* (Linnæus), which is a gibbous species with very short spire, no sculpture, and an enormous parietal callus. The entire family is in need of a critical review and taxonomic revision.

Subgenus NASSARIUS, s. s.

Shell with a relatively low but sharp spire; sculpture essentially of axial ribs with a few faint spiral riblets or striæ; outer lip lirate within and with a posterior notch; anterior canal very deeply notched; inner lip with a few denticles anteriorly and when a posterior notch is well developed a small tooth-like plate just anterior to it; body whorl with a large parietal callus definitely delimited; basal constriction on the body whorl present but not deep.

Nassarius illustrates the difficulties encountered when a more or less homogeneous group is minutely subdivided. The species with a heavy parietal callus on the body whorl, a short spire, and a posterior notch are certainly different, subgenerically, from the thin-shelled, relatively high-spired species with scarcely a sign of callus on the parietal wall. However, many of the other proposed subdivisions result in unnatural groupings; and in many cases they are not only unnatural but are also difficult to apply.[1] In the California Miocene there are some species of *Nassariidæ* with a varixed outer lip like *Uzita* but with sculpture like that of *Alectrion*, only finer grained, as might be expected on small species. The type of *Alectrion*, *A. papillosus*, shows a slight tendency to form a varixed lip, and it is quite possible that these Miocene species belong to a minor branch of *Alectrion* rather than to *Uzita*, the type of which is a west African shell. However, one species, "*Nassa*" *ocoyana* Anderson and Martin,[2] of the California Miocene, has the axial fold-like ribs of the type of *Uzita* and suggests the use of that group. Until more is known of the relative taxonomic values of characters now used as criteria of subgenera and sections and until the true relationships of the Pacific coast Tertiary species to those of other regions is understood, there is certain to be some nomenclatorial disagreement among conchologists. The arrangement adopted below must be considered purely tentative.

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[1] Gabb remarked upon the unnatural arrangement of the species of *Nassa* Lamarck when some of the proposed subdivisional groups are used. (Geol. Surv. Calif., Palæo, Vol. 2, p. 47, 1868-9.)

[2] Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 75, pl. 7, fig. 17, Dec. 30, 1914.

Nassarius (Nassarius) tegula (Reeve)

Plate 26, Figure 43

Nassa tegula Reeve, Conch. Icon., Vol. 8, *Nassa*, pl. 15, fig. 98, December, 1853; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 662, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 74, 1868-9; Pease, Amer. Journ. Conch., Vol. 5, p. 83, 1869; Tryon, Man. Conch., Vol. 4, p. 39, pl. 13, figs. 166, 167, 1882; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 253, 1888; Keep, West Coast Shells, p. 37, fig. 17, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 235, 1903.

Arcularia tegula Reeve, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 577, 1917; Nautilus, Vol. 32, p. 23, 1918.

Alectrion (Zeuxis) tegula Reeve, Dall, U. S. Nat. Mus., Bull. 112, p. 103, 1921; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Alectrion tegula Reeve, E. K Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Alectrion (Schizopyga) tegulus Reeve, Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 267, pl. 26, fig. 10, 1927.

Type locality: Habitat unknown (Reeve); California or Lower California, *fide* Oldroyd.

Pleistocene: Santa Barbara to San Diego (Cooper); lower San Pedro series at Deadman Island and San Pedro, "occasionally found" (Arnold); "Saugus" formation near Ventura (Waterfall); upper San Pedro series at San Pedro, Los Cerritos, Long Beach, Deadman Island, and Crawfish George's, "rare"; also foot of Twenty-sixth Street and at Spanish Bight, San Diego (Arnold); lower Quaternary at Magdalena Bay (Dall, 1918; Jordan, 1924); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).
Recent: San Francisco, California, to Lower California, Mexico.

This is a medium-sized, thick-shelled species with a large callus deposit on the parietal wall of the body whorl. The outer lip is somewhat thickened externally. It is sculptured with low axial folds, which are slightly nodose at the shoulder. The outer lip lacks the deep posterior notch of the type species of *Nassarius*, but the tendency to produce this notch is indicated in some specimens by an incipient groove. Southern specimens of *N. tegula* have heavier axial sculpture and probably grade into *N. luteostoma* (Broderip and Sowerby), of the Panama region. The smaller form inhabiting the Gulf of California has been called *Arcularia tiarula* Kiener.[1]

Nassarius (Nassarius) complanatus (Powys)

Nassa complanata W. L. Powys, Proc. Zool. Soc. London, Pt. 3, p. 96, September, 1835; Reeve, Conch. Icon., Vol. 8, *Nassa*, pl. 17, figs. 111*a*, 111*b*, 1853.

? *Buccinum gemma* Philippi, Abbild. Beschr. Conch., Vol. 3, Heft 5, p. 44, pl. 1, fig. 5, 1849.

Nassa (Zeuxis) complanata Powis, Tryon, Man. Conch., Ser. 1, Vol. 4, p. 33, pl. 10, figs. 105, ? 107, 1882.

Alectrion (Hima) complanatus Powys, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 214, 1909.

Arcularia camplanata Powys, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 577, 1917; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Gulf of Panama south to S. latitude 25° (Dall, 1909). ? Mexican coast.

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[1] *Buccinum tiarula* Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 9, "Buccin," p. 111, pl. 30, fig. 4, 1841, "Habite la mer des Indes sur les côtes de Madagascar," which may be an error.

Nassarius complanatus (Powys) is a rather small species, with the whorls of the spire sculptured by small nodosities and the body whorl nearly smooth except for occasional axial ribs near or under the parietal callus. The outer lip is varicose and has about three denticles within. The posterior notch is represented by a vertical groove in the somewhat ascending callus.

Subgenus **SCHIZOPYGA** Conrad, 1856

Nassa Martini, 1771, name used in a binary but not in a binomial sense.
Nassa Lamarck, 1799, not of Bolten, 1798.
Schizopyga Conrad, Proc. Acad. Nat. Sci. Phila. for 1856, p. 315, December, 1856; U. S. Pacific Railroad Reports, Vol. 6, Pt. 2, p. 69, 1857.

Type (by monotypy), *Schizopyga californiana* Conrad.

Shell rather thin, bucciniform, with a conspicuous constriction on the base of the body whorl; sculpture cancellate or with spiral threads and broad axial folds; outer lip simple, lirate within, the posterior notch not developed; parietal wall concave, with or without a callus wash.

It is probable that some older name could be used here, such as *Tritia* Risso;[1] but the type of that subgenus is not exactly the same. It differs in not having such a deep basal constriction, such a concave inner lip, nor such an abruptly truncated anterior extremity. The sculpture also differs in details. *Schizopyga*, though of later date, is used here for the sake of conservatism. When the nomenclatorial status of Martini's name is determined, it may have to be used.

Alectrion Montfort has been used for the species listed below, but the type of Montfort's genus, *Buccinum papillosum* Linnæus, has a large, heavy shell, a prominent posterior notch on the rather thick outer lip, and a broadly concave columella with a rather narrow but heavy callus deposit projecting anteriorly into a pointed extremity. It is very different from the California shells of the *perpinguis* clan.

Nassarius (Schizopyga) californianus (Conrad)

Plate 26, Figure 49

Schizopyga californiana Conrad, Proc. Acad. Nat. Sci. Phila. for 1856, p. 315, December, 1856; U. S. Pacific Railroad Repts., Vol. 6, Pt. 2, p. 69, pl. 2, fig. 1, 1857; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 593, 1864.
"Nassa fossata Gould," Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 74, in part only, 1868-9.
Nassa californiana Conrad, Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 177, 1891; Arnold, Proc. U. S. Nat. Mus., Vol. 34, pl. 36, fig. 6, 1908; ? U. S. Geol. Surv., Bull. 396, pl. 27, fig. 8, 1910; ? Bull. 398, pl. 49, same figure, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917; probably not, or only in part, of Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 231, not pl. 4, fig. 3, 1903.
Alectrion (Schizopyga) californiana Conrad, Dall, U. S. Nat. Mus., Bull. 112, p. 102, pl. 11, fig. 4, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 264, pl. 26, fig. 13, 1927, reproduction of Dall's figure.
Alectrion californiana Conrad, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Type locality: Santa Clara, California (Santa Clara County); presumed to be Miocene.

Miocene: Santa Clara (Conrad).
Pliocene: Purisima and Merced formations of the San Francisco region; common in the Jacalitos and Etchegoin formations, but lacking in the "*Mya japonica* zone," Coalinga district (Nomland); etc.; etc.
Pleistocene: San Pedro region; lower Quaternary of Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926).
Recent: Oregon to San Ignacio Lagoon, Lower California, Mexico (Dall, 1921).

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[1] Hist. Nat. Eur. Mérid., Vol. 4, p. 172, footnote, 1826, list includes "*Planaxis reticulata*" Linnæus. Type designated by Gray, Proc. Zool. Soc. London for 1847, p. 139, 1847.

Because of the confusion of this species with *N. perpinguis*, *fossatus*, and possibly others, the occurrences given in the literature cannot be depended upon. *N. californianus*, as figured by Conrad, appears to be finely papillose, in a rectilinear pattern. The figures given by Arnold (1910) are of a peculiar young form and cannot be considered typical. *N. californianus* appears to be closely related to *perpinguis*, but whether the shell figured by Dall (1921) as *californianus* is identical with Conrad's presumed Miocene species cannot be said at the present time. Arnold's figure in his San Pedro memoir (1903) is not typical of Conrad's species, and may be of an undescribed variety or even a new species.

Nassarius (**Schizopyga**) **californianus** (Conrad) variety **coalingensis** (Arnold)

Nassa californiana Conrad, var. *coalingensis* Arnold, U. S. Geol. Surv., Bull. 396, p. 88, pl. 27, fig. 9, January 15, 1910; Bull. 398, pl. 49, same figure, 1910.

Type specimen: In the U. S. National Museum, No. 165,511.

Type locality: Henry Spring, four miles south of Coalinga; Pliocene.

Pliocene: Several localities in the Etchegoin formation of the Coalinga region (Arnold).

The variety *coalingensis* is somewhat like *N. perpinguis*, but is more elongate, the whorls of the spire are less ventricose, though slightly tabulated near the suture, and the body whorl is slightly constricted just below the suture. It has much finer sculpture than typical *N. californianus*, particularly as figured by Arnold (1910).

Nassarius (**Schizopyga**) **perpinguis** (Hinds)

Plate 26, Figures 51, 52

Nassa perpinguis Hinds, Zool. Voy. Sulphur, Mollusca, p. 36, pl. 9, figs. 12, 13, 1844; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 662, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 75, 1868-9; Tryon, Man. Conch., Ser. 1, Vol. 4, p. 56, pl. 17, fig. 319, 1882; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 253, 1888; Keep, West Coast Shells, p. 37, fig. 18, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 234, 1903.

Nassa intastriata Conrad, U. S. House of Representatives, House Document No. 129, p. 17, July, 1855, reprinted by Dall, U. S. Geol. Surv., Prof. Paper 59, p. 169, 1909.

Nassa interstriata Conrad, U. S. Pacific Railroad Surveys, Vol. 5, p. 327, 1856, correction in spelling of "*intastriata*."

Nassa perpinguis, var. *bifasciata* Berry, Nautilus, Vol. 22, p. 39, 1908.

Alectrion perpinguis Hinds, Dall, U. S. Nat. Mus., Vol. 51, p. 576, 1917; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 250, 251, 1929.

Alectrion (*Schizopyga*) *perpinguis* Hinds, Dall, U. S. Nat. Mus., Bull. 112, p. 103, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 266, pl. 26, fig. 11, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: In the Zoological Museum, Copenhagen, *fide* I. S. Oldroyd.

Type localities: Of *perpinguis*, Magdalena Bay, Lower California, Mexico, Recent; of *intastriata* Conrad, Santa Barbara, Pleistocene; of variety *bifasciata*, San Pedro, Recent.

? Miocene: Santa Monica and Aliso Creek, Los Angeles County (Cooper).

Pliocene: San Diego well (Dall); "Pico" near Ventura (Waterfall).

Pleistocene: "Pliocene" of Deadman Island and Timms Point; rare in the lower San Pedro series of San Pedro (Arnold, 1903); plentiful in the lower San Pedro of Nob Hill cut, San Pedro (T. S. Oldroyd); irrigation ditch near Ventura (Arnold, 1903); "Saugus" near Ventura (Waterfall); Santa Barbara (Conrad); S. D. S. N. H. locality 74, southwest of Goleta, Santa Barbara County (U. S. G.); at the Chiton bed at Point Firmin (Chace); Spanish Bight and Pacific Beach (Arnold) and near Mexican boundary monument No. 258, San Diego County (Stephens); lower Quaternary at Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926); Santa Monica (F. C. Clark); etc.

Recent: Puget Sound to Magdalena Bay, Lower California, Mexico.

This is the common, evenly ventricose, reticulated species. There is a narrow but distinct shelf just at the suture on most specimens. Berry's variety *bifasciatus* is a color form due to weathering and is of no consequence. Collections of shells of this species (as well as of some other species in this genus) show a tall and a short form which may be due to sexual dimorphism.

N. perpinguis has much finer cancellate sculpture than *N. californianus* (Conrad).

Nassarius (Schizopyga) mendicus (Gould)

Plate 26, Figure 54

Nassa mendica Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 155, 1851; U. S. Expl. Exped. (Wilkes'), Vol. 12, p. 262, Atlas, pl. 19, fig. 331, 1852; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 662, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 74, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 253, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 233, 1903; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 422, 1915; Howe, Univ. Calif. Publ. Geol., Vol. 14, table opp. p. 93, 1922.

Nassa woodwardi Forbes, Proc. Zool. Soc. London for 1850, p. 273, pl. 11, fig. 3, 1850.

Nassa gibbsii W. Cooper, U. S. Pacific Railroad Repts., Supplement to Vol. 1, Part 3, p. 371, 1859.

Alectrion mendicus Gould, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 576, 1917; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Schizopyga mendica Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 102, 1921.

Alectrion cooperi, var. *woodwardi* Forbes, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925.

Alectrion (*Schizopyga*) *mendicus* Gould, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 265, pl. 26, figs. 6, 14, 1927.

Alectrion mendicus indisputabilis I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, pl. 26, fig. 4, 1927.

Alectrion (*Schizopyga*) *mendica* Gould, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: In the collection of the Boston Society of Natural History.

Type localities: Of *mendica*, Nisqually, Port Discovery, Puget Sound; of *gibbsii*, Port Townsend, Puget Sound; both Recent.

Miocene: Empire formation of Coos Bay, Oregon (Howe); Kirker's Pass, Contra Costa County (Cooper); lower San Pablo formation of middle California (Clark).

Pliocene: Twelve Mile House, San Mateo County; Pico near Ventura (Waterfall); San Diego well, San Diego (Cooper); Etchegoin formation of California (Clark); Bath-house Beach, Santa Barbara (Arnold).

Pleistocene: At all the fossiliferous localities in the vicinity of San Pedro (Arnold); lower San Pedro fauna of Nob Hill cut at San Pedro (T. S. Oldroyd); Barlow's Ranch and old irrigation ditch at Ventura, also at Spanish Bight and Pacific Beach, San Diego (Arnold); late Pleistocene southwest of Goleta, loc. 74 (U. S. G.); palisades of Santa Monica (in Oldroyd Collection at Stanford University); chiton bed at Point Firmin, Los Angeles County (Chace); "Saugus" near Ventura (Waterfall); lower Quaternary at Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926); etc.

Recent: Kodiak Island, Alaska, south to Magdalena Bay, Lower California, Mexico (Dall, 1921).

Nassarius mendicus (Gould) has a narrow spire, with fine spiral sculpture and axial plications. It grades into variety *cooperi*, a variety with few, broad undulous axial ribs. *N. mendicus* differs from *perpinguis* in its fewer, more continuous axial ribs. The form figured as *indisputabilis* is of no consequence.

Nassarius (Schizopyga) mendicus (Gould) variety **cooperi** (Forbes)

Plate 26, Figures 40, 50

Nassa cooperi Forbes, Proc. Zool. Soc. London for 1850, p. 273, pl. 11, fig. 4, 1850; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 662, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 74, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 253, 1888; Keep, West Coast Shells, p. 37, fig. 18, 1888, 1892.

Nassa (*Tritia*) *mendica* Gould, var. *cooperi* Forbes, Tryon, Man. Conch., Ser. 1, Vol. 4, p. 56, pl. 17, figs. 322, 323, 1882.

Nassa mendica Gould, var. *cooperi* Forbes, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 234, 1903.

Nassa mendica cooperi Forbes, Berry, Nautilus, Vol. 22, p. 38, 1908.

Alectrion cooperi Forbes, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 576, 1917; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Alectrion mendica Gould, var. *cooperi* Forbes, E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919.

Schizopyga cooperi Forbes, Dall, U. S. Nat. Mus., Bull. 112, p. 102, 1921.

Alectrion (*Schizöpyga*) *cooperi* Forbes, Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 265, pl. 26, fig. 8, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: Said to be Sandwich Islands, possibly a ballast shell.

? Miocene: Kirker's Pass, Contra Costa County (Cooper).

Pliocene: Twelve Mile House, San Mateo County; San Diego well, San Diego (Cooper); Bath-house Beach, Santa Barbara (Berry).

Pleistocene: "Saugus" near Ventura (Waterfall); "Pliocene" and lower and upper San Pedro series of San Pedro (Arnold); southwest of Goleta, loc. 74 (U. S. G.); at the Chiton bed on Point Firmin (Chace); Santa Monica (collection of F. C. Clark); Pacific Beach, San Diego (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Puget Sound to San Diego, California (Dall, 1921).

This variety has fewer but larger axial ribs than the typical *mendicus*. In Tremper's collection there are specimens which show perfect intergradation between typical *mendicus* and the form *cooperi*. There are two forms, a tall and a short, which may represent the different sexes.

Nassarius (Schizopyga) cerritensis (Arnold)

Nassa cerritensis Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 231, pl. 4, fig. 1, 1903.

Alectrion cerritensis Arnold, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 576, 1917; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Schizopyga cerritensis Arnold, Dall, U. S. Nat. Mus., Bull. 112, p. 102, 1921.

Alectrion (*Schizopyga*) *cerritensis* Arnold, 1. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 266, 1927.

Type specimen: In the U. S. National Museum, No. 162,553.

Type locality: Los Cerritos (Signal Hill), Los Angeles County;[1] Pleistocene.

Pleistocene: Los Cerritos, "rather common"; "one or two specimens" from the upper San Pedro series at San Pedro, Long Beach, and Crawfish George's, Los Angeles County; also Spanish Bight, San Diego (Arnold); lower Quaternary at Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926).

Recent: Long Beach, California, to Magdalena Bay, Lower California, Mexico (Dall, 1921).

This species is more elongate than *fossatus* and has fewer axial ribs.

Nassarius (Schizopyga) fossatus (Gould)

Plate 26, Figures 55, 56

Buccinum elegans Reeve, Proc. Zool. Soc. London, Pt. 10, p. 199, Feb., 1843, not *Buccinum elegans* Brown, 1841, nor of Dujardin, 1837, nor of Kiener, 1834, nor of Risso, 1826, nor of Sowerby, 1824, nor of Costa, 1822.

Buccinum fossatum Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 152, 1849.

Nassa reevei A. Adams, Proc. Zool. Soc. London for 1851, p. 109, new name for *Buccinum elegans* Reeve.

Nassa fossata Gould, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 74, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 253, 1888; Keep, West Coast Shells, p. 36, fig. 16, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 232, 1903.

Nassa (*Tritia*) *fossata* Gould, Tryon, Man. Conch., Ser. 1, Vol. 4, p. 55, pl. 17, figs. 316, 317, 1882.

Alectrion fossatus Gould, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 575, 1917; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 11, 1925; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 250, 252, 254, 1929.

Alectrion fossata Gould, E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Schizopyga fossata Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 102, 1921.

Alectrion (*Schizopyga*) *fossatus* Gould, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 264, pl. 26, figs. 1, 3, 5, 7, 9, 1927.

Alectrion (*Schizopyga*) *fossata* Gould, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

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[1] In the original reference, Arnold states that the type came from Los Cerritos. In U. S. Nat. Mus., Bull. 53, p. 426, the holotype is stated to have come from Spanish Bight, San Diego, at which place the new species was *also* stated by Arnold to occur.

Type locality: "Puget Sound and Mouth of Columbia River" (Gould).

Miocene: "Martinez, Walnut Creek, Contra Costa County; Griswold's, San Benito County; Foxin's, Santa Barbara County" (Cooper).

Pliocene: "Danger Creek, Humboldt County; Russian River, Santa Rosa, Sonoma County; Twelve-mile House, and Seven Mile Beach, San Mateo County; west of San Jose, Santa Clara County; Soquel, Santa Cruz County; San Diego well" (Cooper); "Pico" of Ventura district (Waterfall).

Pleistocene: "Pliocene" at Deadman Island, and lower San Pedro series at Deadman Island and San Pedro; old irrigation ditch and Barlow Canyon, Ventura (Arnold); Santa Barbara to San Diego (Cooper); upper Pleistocene terrace southwest of Goleta, Santa Barbara County (U. S. G.); "Saugus" of Ventura district (Waterfall); chiton bed at Point Firmin (Chace) and all upper San Pedro localities in the vicinity of San Pedro (Arnold); several upper Pleistocene localities in San Diego region (Arnold; Stephens); lower Quaternary at Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926); etc.

Recent: Vancouver Island, British Columbia, to Cedros Island, Lower California, Mexico (Dall, 1921).

This large species varies markedly in the strength of its axial ribs. The next form is probably a variety on which the axial ribs are much weaker.

Nassarius (Schizopyga) moranianus (Martin)

Nassa moraniana Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 183, pl. 22, figs. 1*a*, 1*b*, 1*c*, August 6, 1914.
Alectrion grammatus Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 575, 1917.
Alectrion moranianus Martin, Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 49, 1926.
Alectrion (Schizopyga) moranianus Martin, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Shell large, rather solid, oval, whorls of spire rapidly increasing in size, body whorl large, globose; sculpture consisting of rather uniform spiral riblets, with or without small intercalary threads, and axial riblets over which the spirals tend to produce small nodes.

Type specimens: Of *moranianus*, in the collection at the University of California; of *grammatus*, in the U. S. National Museum, No. 101,721.

Type localities: Of *moranianus*, Merced formation of Bolinas Bay, California, Pliocene; of *grammatus*, "Pleistocene of Santa Barbara" (Dall).

Pliocene: Fugler's Point, Santa Barbara County (Carson); "common in the Pliocene formations of the central coast region of California" (Martin).

Pleistocene: Santa Barbara (Dall, as *grammatus*).

Recent: In collections as *gouldii*.

This species is like *fossatus* but is shorter and the axial ribs on the body whorl are finer and not emphasized on the upper portion of the whorl. *Alectrion grammatus* Dall appears to be a synonym and its type locality may be the Pliocene of Santa Barbara instead of Pleistocene as given by Dall.

Nassarius (Schizopyga) waldorfensis (Arnold)

Nassa waldorfensis Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 16, pl. 54, fig. 17, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914.

Type specimen: In the U. S. National Museum, No. 165,272.

Type locality: Waldorf asphalt mine, three miles southeast of Guadalupe, Santa Barbara County, California; Pliocene.

Pliocene: At the type locality; Elsmere, Holser, and Pico canyons, Los Angeles County (English); "found abundantly in the Pliocene throughout southern California" (Arnold, *op. cit.*).

According to Arnold, this species "is slenderer and has coarser axial sculpture than *N. perpinguis* Hinds, and is somewhat smaller, relatively broader, and has much sharper ribs than *N. mendica* Gould; it is more closely related to the latter than to any other of the West Coast species."

Nassarius insculptus (Carpenter)

Nassa insculpta Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 662, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 223, 1866; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 212, pl. 23, fig. 6, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 233, 1903.

Nassa (*Zeuxis*) *insculpta* Carpenter, Tryon, Man. Conch., Ser. 1, Vol. 4, p. 38, pl. 12, fig. 154, 1882.

Alectrion insculptus Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 576, 1917.

Alectrion insculptus, variety *eupleura* Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 576, January 15, 1917.

Zeuxis insculptus Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 103, 1921.

Zeuxis insculptus eupleura Dall, U. S. Nat. Mus., Bull. 112, p. 103, 1921.

Alectrion (*Schizopyga*) *insculptus* Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 267, pl. 26, fig. 12, 1927.

Alectrion (*Schizopyga*) *insculptus eupleura* Dall, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 267, 1927.

Type specimens: Of *insculptus*, in the State collection, University of California, *fide* Oldroyd; of *eupleura*, in the U. S. National Museum, No. 209,046.

Type localities: Of *insculptus*, Catalina Island, California, Recent; of *eupleura*, not stated by Dall, but somewhere between San Simeon, California, and Cedros Island, Lower California, Mexico.

Pliocene: Lower part of the upper Pliocene at Fifth and Hope Streets, Los Angeles, California.
Pleistocene: Upper San Pedro series at San Pedro, "One specimen" (Arnold).
Recent: Point Arena, California, to Cedros Island, Lower California.

Nassarius insculptus (Carpenter) is well figured by Tryon, Williamson and Oldroyd. It is characterized by fine spiral sculpture and by the absence of axial sculpture, except on the small, upper whorls of the spire. The inner lip has a definitely delimited parietal callus. The form *eupleura* is an individual variation of no taxonomic value.

Nassarius versicolor (C. B. Adams)

Nassa versicolor C. B. Adams, Ann. Lyceum Nat. Hist., New York, Vol. 5, p. 66 (pagination of the separate), 1852.

Nassa versicolor var. *striatula* C. B. Adams, *op. cit.*, p. 66, 1852.

Nassa (*Hima*) *versicolor* C. B. Adams, Tryon, Man. Conch., Ser. 1, Vol. 4, p. 50, pl. 15, fig. 270, 1882.

Alectrion versicolor C. B. Adams, Dall, Proc. U. S. Nat. Mus., Vol. 51, p. 576, 1917.

Shell rather small, with spiral threads and axial ribs.

Type locality: Panama; Recent.

Recent: Magdalena Bay, Lower California, Mexico, to Payta, Peru (Dall).

Variety **versicolor**, s. s.

Outline of whorls of spire nearly rectilinear, axial ribs very prominent.

The typical form was stated to have the spiral striæ nearly obsolete on the middle of the whorls. The form covered with very distinct striæ Adams named variety *striatula*.

Nassarius versicolor (C. B. Adams) variety **hooveri** (Arnold)

Nassa versicolor C. B. Adams, var. *hooveri* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 236, pl. 4, fig. 6, 1903.

Shell with a shorter spire and more abruptly truncated anteriorly; axial ribs rounded, sinuous.

Type specimen: In the U. S. National Museum, *fide* Arnold.

Type locality: San Pedro; Pleistocene.

Pleistocene: Upper San Pedro series at San Pedro, two specimens (Arnold).

Subgenus **UZITA** H. and A. Adams, 1853

Uzita H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 120, 1853; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 205, 1901; Woodring, Carnegie Inst., Publ. No. 385, p. 265, 1928.

Type (by subsequent designation, Cossmann, 1901), *Buccinum miga* Bruguière, figured by Reeve, Conch. Icon., Vol. 8, *Nassa*, pl. 13, fig. 86, 1853, and by Tryon, Man. Conch., Ser. 1, Vol. 4, p. 42, pl. 13, fig. 191, ? figs. 192, 193, 1882; west Africa, Recent.

Shell relatively small, stout, abruptly truncated anteriorly, with spiral striæ or cords and axial ribs; aperture broadly ovate, typically with a posterior internal notch or sulcus; outer lip usually varicose, with internal lirations; anterior canal a deep, curved notch; inner lip typically with a sharply delimited callus deposit and some irregular denticles; parietal wall broadly concavely arched.

There is some doubt whether the California Miocene species with varicose outer lips belong to this subgenus. *Nassarius arnoldi* (Anderson) has a varicose lip, but its even, reticulate sculpture suggests a closer relationship with the *Schizopyga* clan. Typical *Uzita* is represented in the Caribbean Miocene by *Nassarius* (*Uzita*) *cercadensis* (Maury) and *gurabensis* (Maury).[1]

Nassarius (Uzita) hamlini (Arnold)

Nassa hamlini Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 537, pl. 50, fig. 9, 1907; U. S. Geol. Surv., Bull. 309, pl. 40, fig. 9, 1907.

Type specimen: In the U. S. National Museum, No. 164,946.

Type locality: Third Street tunnel, Los Angeles; Pliocene.

Pliocene: Third Street tunnel, Los Angeles (Arnold).

No specimen of this species has been examined, and it is possible that the species may not belong to *Uzita*. According to Arnold's figure and description, it has spiral raised lines, axial ribs, a thickened outer lip, and an incrusted inner lip.

Nassarius (Uzita) antiselli (Anderson and Martin)

Nassa antiselli Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 76, pl. 7, fig. 16, 1914.

Type specimen: At the California Academy of Sciences, No. 165.

Type locality: Eastern San Luis Obispo County, Miocene (Anderson and Martin).

Miocene: At the type locality.

? Pliocene: Questionably in the middle Etchegoin from a depth of 2886 feet in a well near Tipton, Tulare County (H. R. G.)

This species has both axial and spiral ribs and a conspicuously varixed outer lip. It closely resembles typical *Uzita*. *N. lincolnensis* (Anderson and Martin) was described as lacking the varix on the outer lip. *N. andersoni* (Weaver),[2] from the Chehalis formation of Washington (Miocene), and *N. pabloensis* (Clark),[3] of the upper Miocene of the Mount Diablo region and Walnut Creek, appear to be closely related to *antiselli* and should probably be treated as synonyms.

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[1] See Woodring, Carnegie Inst., Publ. No. 385, p. 266, plate 16, figs. 4 (*cercadensis*) and 5, 6 (*gurabensis*), 1928.

[2] Washington Geol. Surv., Bull. 15, p. 75, pl. 6, fig. 56, 1912.

[3] Univ. Calif. Publ. Geol., Vol. 8, p. 493, pl. 65, figs. 8, 9, 1915.

Nassarius (Uzita) arnoldi (Anderson)

Nassa arnoldi Anderson, Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 204, pl. 16, figs. 70, 71, December 4, 1905.

Type specimen: In the California Academy of Sciences.

Type locality: "Lower Miocene beds of Kern River."

Miocene: Lower or possibly middle Miocene beds of Kern River (Anderson).

This is a small species with reticulate sculpture and a thickened outer lip. Its sculpture differs from that of typical *Uzita;* but if *antiselli* is a *Uzita,* this species probably is also, for the two species are connected by intermediate forms.

Nassarius (Uzita) arnoldi (Anderson) variety **whitneyi** (Trask)

Plate 26, Figures 48*a*, 48*b*

Nassa whitneyi Trask, Univ. Calif. Publ. Geol., Vol. 13, p. 154, pl. 7, figs. 3, 6, May 10, 1922.

Type specimen: In the collection at the University of California, No. 12,387.

Type locality: Briones formation of middle California.

Miocene: Common throughout the Briones formation, upper Miocene of middle California (Trask).

Pliocene: Middle of the Etchegoin formation at a depth of 2680 feet in a well near Tipton, Tulare County (H. R. G.).

This variety is larger and has more numerous but less prominent ribs. However, it may not be of significance. The outer lip is varicose, but the superficial resemblance to *Nassarius* (*Schizopyga*) *californianus* (Conrad) is shown on plate 26 (compare figures 48 and 49).

Family PYRENIDAE
(COLUMBELLIDAE)

Shell oval, spire more or less developed; aperture oval to elongate and narrow, usually ending in a short, open anterior canal; outer lip simple, or thickened and denticulate or lirate within; inner lip often with denticles, sometimes one or more lirations; average size small; epidermis present; operculum small, horny.

Most of the genera in this family are clearly connected by border-line species. Some species possess some of the characters of two or even three genera and their assignment to any one genus becomes a matter of personal opinion. The subgenera and sections are even less definitely isolated from each other; but there are a number of minor natural groups which deserve separate names, and all that appear to be valid and can be applied to the Pacific coast fauna are recognized below.

Since the Museum Boltenianum is used for nomenclatorial purposes, the family name must be *Pyrenidæ* instead of the more familiar *Columbellidæ.* Should Bolten's catalogue be ruled out by the International Commission on Zoological Nomenclature, the family name will again become *Columbellidæ,* the subgenus *Columbella* will take generic rank, and *Pyrene* will be replaced by *Conella* as a subgeneric group under Lamarck's genus *Columbella.*

If the genus *Columbellaria* Rolle, 1861, properly belongs to the *Pyrenidæ,* the family ranges from the Jurassic to the Recent. The greatest development of the family appears to be in the Recent fauna.

Genus PARAMETARIA Dall, 1916

"*Conella* Swainson," H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 185, October, 1853, not of Swainson, 1840.
Meta Reeve, Conch. Icon., Vol. 11, *Columbella*, discussion under *Columbella picata*, April, 1859; *Meta*, pl. 1, May, 1859; not *Meta* Koch, 1835, *Arachnidæ*.
Parametaria Dall, Nautilus, Vol. 30, p. 25, July, 1916, new name for *Meta* Reeve, 1859, not Koch, 1835.

Type (by subsequent designation, Reeve,[1] 1859), *Conus dupontii* Kiener, figured by Reeve; Gulf of California, Recent.

Shell shaped like that of *Conus* but with denticulations or lirations on the inner side of the outer lip.

Distribution: Tropical and subtropical seas.

This small genus of coniform *Pyrenidæ* has not been found in the fossil state on the Pacific coast. Specimens might readily be confused with *Conus*. The genus grades into *Pyrene* through such species as *ovuloides* C. B. Adams (? = *ovulata* Lamarck).

Genus MICROCITHARA Fischer, 1884

Microcithara Fischer, Man. Conchyl., p. 638, June, 1884.

Type (by monotypy), *C. harpiformis* Sowerby, Proc. Zool Soc. London for 1832, p. 113, 1832; figured by Reeve, Conch. Icon., Vol. 11, *Columbella*, pl. 7, figs. 30*a-b*, 1858; also figured by Tryon, Man. Conch., Ser. 1, Vol. 5, p. 196, pl. 63, fig. 63, 1883.

Distribution: Tropical west American coast.

The most noticeable feature of this genus is the protruding posterior portion of the outer lip. Typically, the shell is cone shaped, with a low spire, but *M. uncinata* (Sowerby)[2] is rather high spired. *M. harpiformis* is a Panama shell.

Tryon (1883) placed these two species in *Columbellina* d'Orbigny,[3] an extinct genus, but they probably do not belong there. *M. harpiformis* has a very long, narrow aperture, approximately equal to the entire length of the shell. *C. monodactylus* has a different shape, the aperture is acutely oval, and the inner lip widely overlaps the body whorl. There has been some doubt whether *Columbellina* belongs to the *Pyrenidæ*.

Genus PYRENE Bolten, 1798

Pyrene Bolten, Mus. Boltenianum, p. 134, 1798.
Conella Swainson, Treat. Malac., pp. 149, 312, fig. 17*a* on p. 151, 1840; type (by monotypy) *C. picata* Swainson (not "*picta* Swainson" Reeve) = *C. ovulata* Lamarck (*fide* Pace), or more likely *discors* (Gmelin).
Pusiostoma Swainson, Treat. Malac., p. 313, 1840; type (here designated) *C. fulgurans* Lamarck, Hist. Nat. Anim. s. Vert., Vol. 7, p. 296, 1822; figured by Reeve, Conch. Icon., Vol. 11, *Columbella*, sp. 50, 1858.
Conidea Swainson, Treat. Malac., p. 313, 1840; type (by monotypy) *Columbella semipunctata* Lamarck, = *C. discors* Gmelin.

Type (by monotypy), *Pyrene rhombiferum* Bolten, 1798, = *Buccinum punctatum* Bruguière, = *Voluta discors* Gmelin. Bolten refers to Martini's figures: Conch. Cab., Vol. 2, [p. 134,] pl. 44, fig. 465, [466, 1773]. This species is figured below, plate 26, figure 42.

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[1] Cited as type in discussion under *Meta macrostoma*, May, 1859. In the April reference referred to above Reeve briefly defines the new genus but ascribes no species to it.

[2] Proc. Zool. Soc. London for 1832, p. 114, 1832, figured by Reeve, Conch. Icon., Vol. 11, *Columbella*, pl. 23, fig. 142, 1858, and by Tryon, Man. Conch., Ser. 1, Vol. 5, p. 196, pl. 63, fig. 64, 1883.

[3] Paléo. Francaise, Terr. Cret., Vol. 2, p. 346, 1842, type, "*C. monodactylus* d'Orbigny," a species from the lower Neocomien (Cretaceous), *fide* Cossmann, Ess. Paléo. Comp., Vol. 4, p. 230, 1901. The original spelling was *Colombellina*, but was emended by Rolle, K. Akad. Wissen. Wien, Sitzunsb. Math.—Natur. Classe, Vol. 42, p. 262, 1861. The genus is represented in North America by *Columbellina americana* Wade, U. S. Geol. Surv., Prof. Paper 137, p. 153, pl. 53, figs. 14, 15, 1926, Ripley formation, upper Cretaceous of Tennessee, but the species appears to be sectionally distinct from *Columbellina*, *s. s.*

Shell large, heavy, elongate-ovate, spire moderate; whorls tightly coiled, sutures channeled or appressed; smooth or spirally sculptured; aperture half to three-quarters length of shell, elongate; outer lip usually thickened in the middle, lirate or denticulate within and sometimes striate on the exterior side, posterior part sometimes expanded or ascending on the body whorl; inner lip lirate or denticulate, sometimes with a small plication deeply placed within the aperture; anterior canal short, rather narrow, slightly recurved or notched, causing the columella to appear obliquely truncated.

Geologic range: Early Tertiary to Recent.

Distribution: World wide in tropical and subtropical waters.

The type of this genus is a Philippine shell, with which a number of tropical west American shells are congeneric.

Subgenus **PYRENE**, s. s.

Exterior of shell smooth, except for low spiral cords around the lower part of the body whorl.

Pyrene (**Pyrene**) **fuscata** (Sowerby)

Columbella fuscata Sowerby, Proc. Zool. Soc. London for 1832, p. 117, 1832; Müller, Synop. Nov. Test. Viv., p. 88, 1836; Sowerby, Thes. Conch., Vol. 1, *Columbella*, p. 114, pl. 36, figs. 21, 25, 1844; Deshayes in Lamarck, Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 10, p. 276, 1844; C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., p. 311, 1852; Reeve, Conch., Icon., Vol. 11, *Columbella*, sp. 9, pl. 2, figs. 9*a*-*b*, 1858; Carpenter, Proc. Zool. Soc. London, p. 344, June, 1863; Rept. Brit. Assn. Adv. Sci. for 1863, pp. 539, 625, 665, 1864; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 105, pl. 42, figs. 19-21, 1883; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 216, 1909; I. S. Oldroyd, Nautilus, Vol. 32, p. 27, 1918; Zetek, Los Moluscos Panama, p. 22, 1918; Orcutt, Nautilus, Vol. 33, p. 67, 1919; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Columbella meleagris Duclos, Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 9, *Columbelle*, p. 10, pl. 3, fig. 3, 1841; d'Orbigny, Voy. Amer. Mérid., Moll., p. 430, 1843.

Pyrene fuscata Sowerby, Tomlin, Journ. Conch., Vol. 18, no. 6, p. 161, 1927.

Pliocene: Southwest point of Coronado Island, Gulf of California, Mexico (Hanna and Hertlein).
Pleistocene: Upper Pleistocene of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Gulf of California, Mexico, to Paita, Peru, and the Galapagos Islands, La Jolla and San Diego (Orcutt).

This species is much like *Pyrene discors* (Gmelin), the type of the genus; but the body whorl is relatively much larger than the penultimate whorl, and spiral sculpture is entirely lacking. The outer lip is thickened in the middle and has numerous small internal lirations. The inner lip has fewer but larger lirations. Recent specimens vary in color, being frequently brown with white maculations. *Columbella meleagris* Duclos, as figured by Kiener, is certainly a synonym. Tryon gives *C. nodalina* Duclos and *C. pallescens* Wimmer as additional synonyms.

Pyrene (**Pyrene**) **strombiformis** (Lamarck)

Columbella strombiformis Lamarck, Hist. Nat. Anim. s. Vert., Vol. 10, p. 266, 1822; Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 9, *Columbelle*, p. 3, pl. 1, figs. 1, 1*a*, 1841; d'Orbigny, Voy. Amér. Mérid., Moll., p. 429, 1843; Sowerby, Thes. Conch., Vol. 1, *Columbella*, p. 110, pl. 36, figs. 1, 2, 1844; C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., Vol. 5, p. 322, 1852; Carpenter, Reigen Coll. Mazatlan Moll. Brit. Mus., p. 490, 1857; Reeve, Conch. Icon. Vol. 11, *Columbella*, sp. 8, pl. 2, figs. 8*a*, 8*b*, 1858; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 104, pl. 42, figs. 5-10, 1883; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 216, 1909; Zetek, Los Moluscos Panama, p. 49, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, pp. 149, 155, 1924.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Cape San Lazaro, Lower California, Mexico, to Payta, Peru.

Pyrene strombiformis (Lamarck) belongs to the group of species with the posterior part of the outer lip distended, forming a shoulder on the apertural portion of the body whorl. In some species, as *paytensis* (Lesson) and *castania* (Sowerby), a tabulation is thus formed below the suture which continues on the spire whorls up to the apex. *P. strombiformis* is very close to *P. major* (Sowerby)[1], as pointed out by Carpenter; but the former is supposed to be somewhat rounder in the spire and it has a color pattern developed in streaks instead of spots. The olive-colored epidermis of *strombiformis* has fine, incised spiral serrations all over, whereas *major* has them only on the upper part of the shell. *Pyrene major* is best regarded as a variety of *strombiformis;* as a fossil it would be indistinguishable from the older species.

Pyrene labiosa (Sowerby)[2] a Recent species of west Colombia, belongs with the group not having a prominent shoulder or tabulation on the whorls and with no spiral sculpture. It has an outer lip much thickened in the middle, causing the aperture to be narrow and sinuous. The lip flares slightly externally because of the unusual thickening. "*Columbella venilia* Duclos" is said to be a synonym.

Pyrene paytensis (Lesson), a Recent species ranging from Panama to Peru, has a sloping tabulation below the suture, as previously mentioned. This tabulation is emphasized in *P. castania* (Sowerby), occurring in Central American waters and at the Galapagos.

Pyrene hæmastoma (Sowerby), of the Pacific coast of Mexico, Gulf of California, and the Galapagos, belongs to the *strombiformis* group, but has distinctive coloration. Kiener has a very fine figure of this species.[3]

"*Columbella*" *bovini* Kiener,[4] a Panama shell, has strongly nodulous whorls and belongs in a different section.

It is interesting to note here that *Pyrene rustica* (Linnæus), of the Mediterranean and west African coasts, in some of its variations is similar to *P. fuscata* (Sowerby). In general, *fuscata* tends to have a proportionately larger body whorl and lower spire, and it lacks the spiral sculpture entirely. The spiral sculpture on the lower part of the body whorl of *rustica* is variable in strength, however, and is entirely lacking in some specimens, while very strong on others. *Pyrene rusticoides* (Heilprin), originally described as a fossil, occurs in the Recent fauna of the Atlantic coast. It is clearly related to *rustica;* but, judging from shell characters, it is less closely related to the African shell than is *fuscata.*

Some species of *Pyrene* have a plication on the columella deep within the aperture. This is often present on *P. strombiformis.* As pointed out by Dall for the *Volutidæ*, columellar plications are the mechanical result of the folding of the mantle of the animal when it is drawn into the body whorl. The deeply placed columellar plications on *P. strombiformis, P. major*, and *P. fuscata* are variable in strength and position on the pillar. Often there is a double plication placed behind the denticulations and just above the point where the oblique truncation of the columella begins. Little systematic importance should be attached to these rather indefinite, variable plications, which are merely a function of the amount of constriction and folding of the withdrawn mantle.

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[1] Sowerby, Proc. Zool. Soc. London for June, 1832, p. 119.

[2] Sowerby, Genera of Shells, No. 9, fig. 2, 1824.

[3] Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 9, *Columbelle*, pl. 10, fig. 2, 1841.

[4] Kiener, *op. cit*, p. 47, pl. 11, fig. 1, 1841.

Subgenus **COLUMBELLA** Lamarck, 1799

Columbella Lamarck, "Prodrome," Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 70, 1799.
Columbus Montfort, Conch. Syst., Vol. 2, p. 590, 1810.

Type (by monotypy), *Voluta mercatoria* Linnæus.

Shell like that of *Pyrene, s. s.*, but with spiral striations on the whole of the exterior.

The only species given by Lamarck in his Prodrome under the new genus *Columbella* is *Voluta mercatoria* Linnæus, which is thus the type by monotypy. Eleven years later Denys de Montfort proposed the generic name *Columbus*, illustrating as type this same *V. mercatoria* L., which makes the later generic name an exact synonym of *Columbella*. The generic name *Columbella* Lamarck has been placed on the official list of genera by Opinion 94 of the International Commission on Zoological Nomenclature.[1]

Pyrene (*Columbella*) *mercatoria* (Linnæus) is a Recent species of the West Indies and Florida. We have carefully compared a series of specimens with *Pyrene discors* (Gmelin), the type of *Pyrene*, and have concluded that the differences in shell characters are not of generic importance. The only difference we have found to distinguish these two subgenera is the relative strength or extent of the spiral sculpture, a character which is certainly quite variable in many gastropods.

Columbella, as properly restricted, is not represented in the Pliocene or Pleistocene, nor in the living fauna of the Pacific coast, so far as is known at this time. The well-known California Recent species commonly grouped under *Alia* and *Astyris* as subgenera of *Columbella* belong to Risso's genus *Mitrella*. *Columbella cosmia* Dall,[2] of the Pliocene marl of Shell Creek, Florida, is a *Pyrene, s. s.*, and not a *Columbella*.

Eurypyrene has been proposed by Woodring[3] to include the forms that have a wider aperture than *Pyrene, sensu stricto*, the outer lip lacking the inward bulge. The interior of the outer lip has lirations instead of denticulations, and the posterior channel is wider and shorter and is bordered on the parietal wall by a callus ridge. This section is not present on the Pacific coast.

Subgenus **NITIDELLA** Swainson, 1840

Nitidella Swainson, Treat. Malac., p. 151, fig. 17*c*, p. 313, 1840, *Columbella nitida* Lamarck, only species listed; Mörch, Journ. Conchyl., Vol. 7 (Ser. 2, Vol. 3), p. 256, 1859.

Type (by monotypy), *Columbella nitida* Lamarck, figured by Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 9, *Columbelle*, pl. 15, figs. 1, 1841.

Like *Pyrene, s. s.*, but shell thinner, more elongate; inner lip not incrusted with callus, columellar plications more evident.

In his generic description Swainson mentions but one species, *Columbella nitida* Lamarck, which, in a footnote, he renames *Nitidella marmorata*, thus creating an exact synonym of Lamarck's species. Mörch later considered Swainson's figure (p. 151, fig. 17*c*) a species distinct from Lamarck's *nitida*, which he accordingly named *C. swainsoni*.[4]

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[1] Smithsonian Misc. Coll., Vol. 73, p. 12, 1926.

[2] Figured in Trans. Wagner Free Inst. Sci., Vol. 3, pt. 6, pl. 58, fig. 2, Sept. 30, 1903.

[3] Woodring, W. P., Carnegie Inst., Publ. No. 385, p. 272, 1928, type by original designation *Pyrene* (*Eurypyrene*) *eurynotum* Woodring, *op. cit.*, p. 272, a Miocene Caribbean species.

[4] A comparison of Swainson's figure with Kiener's figure of *nitida* shows them to be conspecific. Reeve (Conch. Icon., Vol. 11, *Columbella*, pl. 11, figs. 52*a*-*b*, 1858) figures Sowerby's *nitidula* for Lamarck's *nitida*, but the differences are hardly specific.

Nitidella nitida (Lamarck), the type of this subgenus, is a West Indian shell which differs little from small specimens of *P. discors.* Aside from the differences mentioned above, the aperture of the type of *Nitidella* is not sinuous, the outer lip has less central thickening, and there are fewer whorls in the spire. The apex tends to become blunt in many specimens.

Nitidella is clearly a connecting link between *Pyrene* and *Mitrella.* While there seems to be little connection between the heavy-shelled, thick-lipped Pyrenes having narrow, sinuous apertures, such as *P. labiosa, P. paytensis,* and *P. major,* on the one hand, and the thin-shelled Mitrellas, such as *M. scripta* and *M. elegans,* on the other, the extremes merge gradually into each other through numerous intermediate species. Thus *P. discors,* the type of *Pyrene,* is clearly related to the group with the extremely thickened lip through such species as *fuscata.* In the other direction, *P. discors* is related through *P. nitidula* Sby. to *P. nitida;* and this latter species has a variant with an oval aperture and a columella on which the plication is obsolete or reduced to a low ridge on the lower margin. Some of these variants could be placed in *Mitrella* without unduly extending the limits of that genus. Such connecting links between related genera occur frequently and make the selection of sharp generic division lines either impossible or purely a matter of convenience and personal judgment. We have retained *Nitidella* because it seems to represent a minor group that is recognizable to one who has become familiar with the family. As the type of *Nitidella* shows greater similarity to the type of *Pyrene* than to the type of *Mitrella,* it seems better to assign *Nitidella* to the former.

On the Pacific coast there appears to be no fossil representative of *Nitidella* as properly restricted. "*Nitidella*" *gouldii* Carpenter is a *Mitrella,* although it is a step toward *N. nitida* from *M. scripta.* We have not seen specimens of *Mitrella lutulenta* (Dall), doubtfully referred to *Nitidella* by its author, but the description suggests that it is a *Mitrella.*

Carpenter at an early date introduced the name *Nitidella* into Pacific coast usage because Gray had used it for Columbellas with Purpuroid opercula and it seemed to afford a place for *cribraria* Lamarck.

Genus ANACHIS H. and A. Adams, 1853

Anachis H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 184, 1853, list includes *Columbella scalarina* Sowerby; Chenu, Man. Conchyl., Vol. 1, p. 202, 1859; Tate, Appendix to Woodward's Man. Moll., Ed. 3, p. 13, 1875 (also Ed. 4, p. 13, 1880), type cited, *Columbella scalarina* Sowerby; Tryon, Man. Conch., Ser. 1, Vol. 5, pp. 102, 152, 1883; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 236, 1901, type stated to be *Columbella rugosa* Sby.; Woodring, Carnegie Inst., Publ. No. 385, p. 276, 1928, type *Columbella scalarina* Sowerby.

Atilia H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 184, 1853, list includes *Columbella suffusa* Sowerby; Chenu, Man. Conchyl., Vol. 1, p. 201, 1859; type (here designated) *Columbella suffusa* Sowerby.

Type (by subsequent designation, Tate, 1875), *Columbella scalarina* Sowerby, figured by Sowerby, Thes. Conch., Vol. 1, *Columbella*, pl. 39, fig. 118, 1844; and by Reeve, Conch. Icon., Vol. 11, *Columbella*, sp. 11, pl. 3, figs. 11*a*, 11*b*, 1858; and by Tryon, Man. Conch., Ser. 1, Vol. 5, pl. 54, fig. 39, 1883.

Shell like that of *Pyrene* but with axial ribs and in many cases smaller.

Geologic range: Miocene to Recent (? Eocene of Australia).

Distribution: Tropical and temperate seas.

The first valid type designation for this genus seems to be that of Tate, who chose *Columbella scalarina* Sowerby. This species is like some of the tabulated Pyrenes but has strong axial sculpture. The tabulation or shoulder on the upper margins of the whorls is a variable character in this family and should be regarded as of little more than specific value. We therefore use *Anachis, sensu lato,* to include both the tabulated forms and the smooth ones. *Atilia* H. and A. Adams, of which the type[1] is *C. suffusa* Sowerby, is a synonym of *Anachis.* It can not well serve as a section to include the untabulated species, since *C. suffusa* has a small shoulder on the body whorl. Such a division of the genus would only lead to confusion.

Carpenter[2] stated that *Anachis* was characterized by an operculum similar to that of *Pisania;* but as opercula are not well known even in living shells and in this case do not seem to be significant, the more enduring shell characters are given more weight.

Subgenus **ANACHIS,** s. s.

Shell relatively large, short, typically with flattened whorls, shouldered near the suture; aperture subquadrate, outer lip thickened and denticulate, inner lip often with a callus deposit, denticulate or lirate.

The typical subgenus differs from *Chauvetia* in the relatively lower spire and in general in the larger, heavier shell. The species of *Chauvetia* usually have more pronounced spiral sculpture than typical *Anachis. Anachis gaskoini* Carpenter, is figured on plate 26, figure 47, to illustrate the form of typical *Anachis.*

Anachis (**Anachis**) **coronata** (Sowerby)

Columbella coronata Sby., Proc. Zool. Soc. London for 1832, p. 114, 1832; Thes. Conch., Vol. 1, *Columbella,* p. 135, sp. 70, pl. 39, fig. 134, 1844.

Type specimen: In the British Museum.

Type locality: Gulf of Panama; Recent.

Pleistocene: Scammons Lagoon, Lower California, Mexico (coll. San Diego Society Nat. Hist.).
Recent: Magdalena Bay to Ecuador.

This species is quite variable in the development of the axial sculpture. A series of Recent specimens from the west coast of Lower California shows a variation from rounded nodes on the upper shouldered part of the whorls to elongate axial ribs extending down the side of the whorl and varying considerably in number on different specimens from the same locality. The fossil specimens providing the Pleistocene record given above are on an average somewhat larger than Recent individuals, the largest being nearly 10 millimeters long. They are slightly tabulated below the suture and the axial ribs are nodose on the shoulder of the body whorl.

Anachis (**Anachis**) **solidula** (Reeve) variety **præcursor** (Arnold)

Columbella solidula Reeve, var. *præcursor* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 236, pl. 10, fig. 4, 1903.

"Shell small, broadly fusiform; spire elevated; apex rounded, whorls seven, only slightly convex, slightly shouldered above, smooth; body whorl two-thirds length of shell, with row of nodes on shoulder, each node being the termination of a faint transverse ridge which becomes obsolete on lower portion of whorl; columella with spiral sulcations on exterior; aperture rhomboidal, narrow; outer lip thickened internally by row of prominent teeth; inner lip smooth; canal short, recurved.

"Dimensions.—Long. 14.5 mm.; lat. 65 mm.; body whorl 10 mm.; aperture, including canal, 7.5 mm.; canal 1 mm.; defl. 42 degrees." (Arnold, 1903.)

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[1] Cossmann, Ess. Paléo. Comp., Vol. 4, p. 242, 1901, states the type to be *Mitrella minor* Scacchi, but that species is not in the original list of species assigned to the genus by its authors and can not serve as type. As the citation by Pace, 1902, of *C. suffusa* may be ruled out on a technicality, we have definitely designated that species here.

[2] Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 505, 1857.

Type specimen: In the U. S. National Museum.

Type locality: "Upper San Pedro series at San Pedro," California, Pleistocene.

Pleistocene: Upper San Pedro series (Palos Verdes formation) at San Pedro (Arnold).

Only the type specimen of this variety has been reported. Arnold's description and figure suggest that it is very close to the typical variety and that Arnold's varietal name should be discarded. The description mentions the rounded apex, which is not thus shown in the figure. Reeve's description of the type of *solidula*[1] gives that shell a sharp spire; but a specimen apparently of *solidula* in the Oldroyd Collection at Stanford University has a decidedly obtuse apex; in fact, the nucleus is depressed, giving the spire a truncated appearance. The few widely spaced spiral striations below the suture on this specimen are quite faint and would undoubtedly be effaced if subjected to erosion. Arnold's description and figure do not include these striations.

Subgenus **CHAUVETIA** Monterosato, 1884

Lachesis Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 211, 1826; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 112, 1883; not *Lachesis* Daudin, 1804 (Reptilia).

Nesæa Risso, *op. cit.*, p. 223, pl. 5, fig. 69, 1826; Bucquoy, Dautzenberg, and Dollfus, *op. cit.*, p. 112, 1883; not *Nesæa* Lamour, 1812.

Donovania Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 112, "Type: *D. minima*" Montagu, pl. 15, figs. 26-32, 1883; not *Donovania* Leach, Brewster's Edinburgh Encyclopedia, Vol. 7, p. 435, 1814.

? Folineæa Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 136, 1884, type by virtual tautonomy and subsequent designation (Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 326, 1918) *Buccinum lefebvrii* Moravigna, 1840, + "*Buccinum*" *folineæ* Philippi, non Delle Chiaje, this species being in the original list.

Chauvetia Monterosato, *op. cit.*, p. 137, 1884, type by original designation, "*Buccinum*" *candidissimum* Philippi; Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 323, 1918.

? Nassarina Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 18, p. 181, 1889, type by original designation, *Nassarina bushii* Dall, Recent West Indies and Florida, figured in U. S. Nat. Mus., Bull. 37, pl. 15, fig. 12, 1903; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 279, 1928.

Folinia Monterosato, 1890, not *Folinia* Crosse, 1868.

Syntagma Iredale, Proc. Malac. Soc. London, Vol. 13, p. 34, 1918, new name for *Donovania* Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 112, 1883; type *Buccinum brunneum* Donovan, 1803, + *Buccinum minimum* Montagu, 1803. (If *brunneum* is on pl. 179 of Donovan's Hist. Nat. Brit. Shells as cited by Forbes and Hanley, that is in the last part of Vol. 5, it appeared, according to the Cat. Nat. Hist. Books Brit. Mus., about June, 1804, and Montagu's name has priority.)

Type (by original designation), *Buccinum candidissimum* Philippi.

The shells of this subgenus are usually smaller, higher spired, with a more slender columella and thinner outer lip than those of typical *Anachis*. The outer lip usually, but not always, lacks denticulations. *Chauvetia* is distinguished from *Mangelia* by the shorter columella, which is truncated or twisted at the end, by the somewhat notched anterior canal, and by the more rounded aperture and the presence of an operculum. *Aesopus* is very different in sculpture.

Anachis (Chauvetia) lineolata (Gray in Reeve)

Plate 26, Figures 31, 34

Pleurotoma lineolata Gray MSS., Reeve, Conch. Icon., Vol. 1, *Pleurotoma*, pl. 37, fig. 337, 1846.

Not *Lachesis lineolata* Tiberi, Journ. de Conchyl., p. 76, pl. 5, fig. 5, 1868, a color variety of *candidissima* Philippi.

Clathurella lineolata Gray, Tryon, Man. Conch., Vol. 6, p. 295, pl. 21, fig. 14, 1884.

Mangilia lineolata Reeve, Dall, Bull. 112 U. S. Nat. Mus., p. 82, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 144, 1927.

Anachis minuta T. S. Oldroyd, Nautilus, Vol. 34, p. 114, April, 1921, not *Columbella* (*Anachis*) *minuta* Gould, Proc. Bost. Soc. Nat. Hist., Vol. 7, p. 334, 1860.

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[1] Reeve, Conch. Icon., Vol. 11, *Columbella*, sp. 149, Feb., 1859.

Shell small, thick for its size, high spired; whorls rounded, sutures not deep, the whole surface of the shell sculptured with strong spiral cords, three or four showing on the spire whorls and nine or ten on the body whorl, axial riblets weaker, about 12 to a whorl, low, rounded, narrower than the interspaces; aperture short, narrow, rounded at the posterior end, outer lip at some stages of growth with two or three obscure denticles, columella straight in the upper portion but sometimes strongly twisted to the left at the lower end, anterior canal short, narrow, notched behind.

Dimensions: Altitude 5 mm., length of aperture 1.7 mm., diameter of body whorl 1.8 mm.

Pleistocene: Upper Pleistocene at Santa Monica, Los Angeles Co. (T. S. Oldroyd).
Living: Catalina Island to Panama and the Galapagos Islands (Dall).

This species is easily distinguished by its strong spiral cords. Its notched anterior canal and the denticles on the interior of the outer lip show it to be a *Chauvetia* instead of a *Mangelia*. Reeve's figure is very poor, not showing the sculpture properly (as Reeve remarks himself), and showing the aperture relatively too long. The writers do not know upon what basis the identification of Reeve's name with the Pacific coast shell was made; but since the identification has been made, they are inclined to follow it until definite evidence is produced to show that it is wrong. *A. penicillata* has stronger axial ribs, a thinner shell, and usually a trace of a shoulder at the top of the whorl.

Anachis (Chauvetia) penicillata Carpenter

"*? Anachis*" *penicillata* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 537, 664, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 23, 150 (bottom pagination), 1872; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 398, 1865, reprinted in Smithsonian Misc. Coll., No. 252, pt. K, p. 288 (bottom pagination), 1872.

Columbella penicillata Carpenter, Tryon, Man. Conch., Ser. 1, Vol. 5, p. 177 (unfigured), 1883; T. S. Oldroyd, Nautilus, Vol. 25, no. 7, p. 74, 1911; Lowe, Nautilus, Vol. 27, no. 3, p. 27, 1913.

Anachis penicillata Carpenter, Baker, Nautilus, Vol. 16, p. 40, 1902; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, p. 12, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 270, 1927.

Columbella (*Anachis*) *penicillata* Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 103, 1921.

Shell small, long, high spired; whorls six, convex, regularly enlarging, slightly shouldered below the suture; sutures linear, depressed; sculpture consisting of prominent rounded axial ribs, numbering about 14 on the body whorl, continuous from suture to suture, fading out gradually on the lower part of the body whorl, crossed by continuous, evenly spaced, rounded spiral threads, which sometimes give a beaded effect to the axial ribs; aperture about one-third of the total length of the shell, ovate-subquadrate; outer lip simple, not denticulated, with a very shallow, broad, indented sinus below the suture; columella without denticulations or plications, sometimes polished at the inner lip; anterior canal short, slightly notched behind.

Dimensions: Altitude 6 mm.; diameter 2.2 mm.

Type specimen: Formerly in the "Coll. Boyce, Utica, N. Y."; present location unknown.

Type locality: "Santa Barbara, San Diego, Catalina Island."

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); upper San Pedro, Signal Hill, Los Angeles County (T. S. Oldroyd collection).
Recent: Santa Barbara, California, to Gulf of California, Mexico (Dall, 1921).

This species is easily distinguished from *subturrita* Carpenter[1] by its more elongate aperture, longer columella, and stronger sculpture. *A. subturrita* has an unusually short columella. *A. pulchrior* (C. B. Adams) is a broader, relatively lower spired form which frequently has teeth on the inside of the outer lip. Specimens of this last species from San Hipolite Point, Lower California, show much variation in strength of sculpture, some individuals having very low axial ribs and the spiral threads obsolete except on the base of the body whorl. C. B. Adams[2] described this shell as having a "surface smooth and shining"; but the specimens we have seen are not quite typical, the nearest having reduced sculpture mentioned above.

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[1] Carpenter, Proc. Calif. Acad. Sci., Vol. 3, p. 223, 1866. *Anachis petraris* Dall (Proc. U. S. Nat. Mus., Vol. 34, p. 250, 1908) is a synonym. *A. subturrita* is figured by Tryon, Man. Conch., Ser. 1, Vol. 5, pl. 58, fig. 47, 1883.

[2] *Columbella pulchrior* C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., Vol. 5, (p. 96 of the separate), 1852.

Anachis (Chauvetia) arnoldi (Dall)

Columbella (*Anachis*) *minima* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 237, pl. 9, fig. 8, 1903. Not *Columbella minima* Tenison-Woods, 1878 (error for *minuta* Angas), nor of Bucquoy, Dautzenberg, and Dollfus, 1882, nor of Sacco in Bellardi, 1890, nor of J. Hervier, 1899.

Columbella (*Anachis*) *arnoldi* Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 250, 1908, new name; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 163, 1924.

"Shell small, resembles a young *Amphissa corrugata* but much slenderer; surface sculptured by numerous transverse ridges and fine spiral sulcations; whorls six, shouldered above as in *Amphissa versicolor;* aperture subquadrate; outer lip nearly straight; pillar straight, spirally striated.

"Dimensions.—Long. 6 mm.; lat. 2.4 mm.; body whorl 3.5 mm.; aperture 2.2 mm.; defl. 28 degrees." (Arnold, 1903.)

Type specimen: In the U. S. National Museum.

Type locality: Upper San Pedro series of San Pedro; Pleistocene.

Pleistocene: At the type locality, rare (Arnold).

Arnold's figure is of a shell somewhat resembling in shape Recent specimens in the Oldroyd Collection at Stanford University, labeled "*Columbella fluctuata*" Sowerby, from San Ignacio Lagoon, Lower California, Mexico; but neither Arnold's figure nor description indicates the presence of teeth on the outer lip, which are present in the Recent species, and the spiral sculpture on Arnold's figure is shown all over the shell. Notwithstanding the *Amphissa*-like characteristics, the species may belong to *Anachis*. We have seen no specimens.

The following is a list of the Recent species of *Anachis* reported from the Pacific coast of North America, with their geographic range so far as known:

A. adelinæ Tryon, 1883. West Mexico.
A. albonodosa Carpenter, 1857. Mazatlan.
A. atramentaria Sowerby, 1844. Panama and Galapagos.
A. bartschii Dall, 1916. Gulf of California (= ? *tæniata* Phil.)
A. coronata Sowerby, 1832 (not of Seguenza, 1880, = *C. bronni* Mayer, 1869). Gulf of California to Panama.
A. cruentata Mörch, 1860. Central America.
A. diminuta C. B. Adams, 1852. Gulf of California to Panama.
A. elegantula Mörch, 1861. Central America and Galapagos.
A. encaustica Reeve, 1858. Gulf of California.
A. fluctuata Sowerby, 1832 (+ *saturalis* Gray, 1834), Gulf of California to Peru.
A. fulva Sowerby, 1832 (not of Brusina, 1870). Mazatlan to Panama.
A. fuscostrigata Carpenter, 1864. Cape San Lucas.
A. fusidens Dall, 1908. Galapagos.
A. gaskoini Carpenter, 1857 (+ *C. tæniata* Philippi, 1846, not Link, 1807 + ? *bartschii* Dall, 1916). Point Abreojos, Lower California, to Acapulco and Peru.
A. humerosa Carpenter, 1865. Acapulco, Mexico.
A. lineolata Gray in Reeve, 1846. Catalina Island to Panama and Galapagos.
A. lentiginosa Hinds, 1844 (+ *tessellata* C. B. Adams, 1852, not Dunker, 1871; + *guatemalensis* Reeve, 1859; not *lentiginosa* Reeve, 1859). Panama to Peru.
A. milium Dall, 1916 (+ *Columbella* (*Anachis*) *parva* Sowerby, 1844, not "*Buccinum*" *parvum* H. C. Lea, 1841, nor *Columbella* (*Anachis*) *parva*, Sacco in Bellardi, 1890). Gulf of California to Ecuador.
A. moesta C. B. Adams, 1852. Panama.
A. nigricans Sowerby, 1844. Gulf of California to Panama and Galapagos.
A. nigrofusca Carpenter, 1857. Gulf of California; west coast of Mexico.
A. nigropunctata Sowerby, 1832. Galapagos.
A. pachyderma Carpenter, 1857. Mazatlan.
A. pariolida Duclos, 1835 (April, 1840). Central America ?

A. penicillata Carpenter, 1864. Santa Barbara, California, to Gulf of California, Mexico.
A. phanea Dall, 1919. Salina Cruz, Mexico.
A. pulchrior C. B. Adams, 1852 (? not of Carpenter, 1864). Point San Hipolito, Lower California, to Panama.
A. pygmæa Sowerby, 1832 (not of Bellardi, 1890). Point Abreojos, Lower California, to Peru.
A. reedi Bartsch, 1928. Bay of Guayaquil, Ecuador.
A. reevei Carpenter, 1864 (see *A. santa-barbarensis* Carpenter, 1864).
A. rufotincta Carpenter, 1857. Point Abrejos, Lower California, to Panama.
A. rugosa Sowerby, 1832. Panama.
A. rugulosa Sowerby, 1844. Gulf of California to Peru and the Galapagos.
A. santa-barbarensis Carpenter, 1856. (Carpenter renamed this species *reevei* in 1864 because it was found not to occur at Santa Barbara, California; but although *reevei* is now the better known name, the original will have to take its place, if the rules are to be followed). Gulf of California to Acapulco, Mexico.
A. scalarina Sowerby, 1832 (+ *costellata* C. B. Adams, 1852, not of Broderip and Sowerby, 1829). Magdalena Bay, Lower California, and Gulf of California to Panama.
A. serrata Carpenter, 1857. Magdalena Bay, Lower California, to Gulf of California.
A. solidula Reeve, 1859. Magdalena Bay to Ecuador.
A. spadicea Philippi, 1846. Mazatlan.
A. strongi Bartsch, 1928. Guayaquil Bay, Ecuador.
A. subturrita Carpenter, 1866. San Pedro, California, to Todos Santos Bay, Lower California, Mexico.
A. suffusa Sowerby, 1844. Central America to Panama; Galapagos.
A. sulcosa Sowerby, 1832. Panama, Galapagos.
A. terpsichore, "Leathes," Sowerby, 1822 (not Menke, 1851, nor Kiener, 1841; + *lyrata* Sowerby, 1832). Lower California, Mexico, to Peru.
A. tincta Carpenter, 1864. Cape San Lucas, Lower California; ? Galapagos.
A. varia Sowerby, 1832. Gulf of California to Panama.
A. varians Sowerby, 1832 (not *varians* Hutton, 1885). Galapagos.
A. varicosa Gaskoin, Oct. 28, 1852. Gulf of California, Mexico, to Chile.
A. whitei Bartsch, 1928. Guayaquil Bay, Ecuador.

Such a list indicates that many names need to be synonymized.

Genus MITRELLA Risso, 1826

Mitrella Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 247, 1826, list comprises *M. flaminea* Risso, *M. levigata* Risso, *M. costulata* Risso, and *M. turgidula* Brocchi; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 235, 1901, type cited, *Murex scriptus* Linnæus; Pace, Proc. Malac. Soc. London, Vol. 5, p. 44, April, 1902; Cox, Rept. Pal. Zanzibar, Moll., p. 28, 1927, type cited *M. flaminea* Risso; Woodring, Carnegie Inst., Publ. No. 385, p. 273, Nov., 1928, type, *Mitrella flaminea* Risso (= *Murex scriptus* Linnæus).

Not *Mitrella* Swainson, Elem. Conch., 1835, = *Swainsonia* H. & A. Adams, 1853.

Alia H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 183, 1853, list includes *C. carinata* Hinds; Mörch, Journ. Conchyl., Vol. 7, (Ser. 2, Vol. 3), p. 257, March, 1859; Chenu, Man. Conchyl., Vol. 1, p. 201, 1859, example, *C. unifasciata* Sowerby; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 232, 1901, type cited, *Columbella carinata* Hinds; Pace, Proc. Malac. Soc. London, Vol. 5, p. 41, April, 1902.

Astyris H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 187, 1853, list includes *Columbella rosacea* Gould; Mörch, Journ. Conchyl., Vol. 7, (Ser. 2, Vol. 3), p. 257, 1859; Tryon, Struct. Syst. Conch., Pt. 2, p. 179, 1883, *C. clausiliæformis* Kiener, listed; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 238, 1901, type *Columbella rosacea* Gould; Pace, Proc. Malac. Soc. London, Vol. 5, p. 42, 1902.

"*Mitsella* Risso" Mörch, Journ. Conchyl., Vol. 7 (Ser. 2, Vol. 3), p. 257, 1859, misspelling for *Mitrella*.

? *Alcira* H. Adams, Proc. Zool. Soc. London for 1860, p. 450, *A. elegans* H. Adams, monotype.

Columbellopsis Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 77, 1882, *Columbella minor* Scacchi designated as type, figured on pl. 13, figs. 9 and 10; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 242, 1901; Pace, Proc. Malac. Soc. London, Vol. 5, p. 43, 1902; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 274, 1928.

? *Angulatomitrella* Sacco, 1889, *fide* Cossmann, p. 235, 1901.

? *Arcuatomitrella* Sacco, 1889, *fide* Cossmann, p. 235, 1901; Pace, Proc. Malac. Soc. London, Vol. 5, p. 42, 1902, type, *C. præcedens* Bellardi.

? *Fluella* Dall, Proc. Biol. Soc. Wash., Vol. 37, p. 87, 1924, type, *Astyris* (*Fluella*) *vidua* Dall.

? *Plectaria* Dall, Proc. Biol. Soc. Wash., Vol. 37, p. 87, 1924, type, *Astyris* (*Plectaria*) *crumena* Dall.

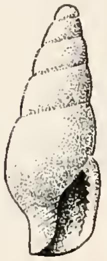
Type (by subsequent designation, Cox, 1927), *M. flaminea* Risso = *Murex scriptus* Linnæus.

Shell of medium weight, rather high spired, acutely conical; whorls almost flat to moderately ventricose, sutures linear, slightly impressed; spiral sculpture confined to basal portion of body whorl (typically) or uniform over entire shell; aperture small, elongate-ovate, one-half or less the length of the shell; outer lip sometimes thickened and denticulate or lirate within; inner lip with or without lirations or denticulations on columella, which is short or obliquely truncated; anterior canal hardly or not at all differentiated from the basal portion of the aperture; posterior canal undeveloped or represented by a slight flare or shallow channel on the outer lip at junction with body whorl. Size generally small.

Geologic range: Oligocene to Recent.

Distribution: World wide.

This genus was established by Risso in 1826, the first species in his list being *M. flaminea* (figure 144), which has generally been considered the genotype. Risso's figure is clearly recognizable as *Murex scriptus* Linnæus, and it has been considered as such by subsequent authors. Mörch, in his paper on the lingual dentition of the *Columbellidæ* (1859), points out that Risso's generic description accords very well with the first species "*C. scripta* L. (*B. Linnæi* Payr.) qui doit être regardée comme le type." Cossmann likewise cited *Murex scriptus* Linnæus as the type, but like Mörch, made no mention of Risso's original name. These type designations probably will not hold, since Risso's specific name is not mentioned, although Mörch indirectly indicated it by his reference to the "first species." Gray,[1] in his synonymic type list of 1847, does not help out in this case, merely citing "*flammea*" under *Columbella* and most of the other species in other families. Tryon, in the "Manual of Conchology" (Vol. 5, p. 214, 1883), cites "*flaminea* Scacchi (Cat. p. 10)" as a synonym of *C. scripta* Linnæus. Although it is clear which of Risso's species is meant by the above authors, it remained for Cox in 1927 to designate definitely the type of *Mitrella* by citing *M. flaminea* Risso and its equivalent, *M. scriptus* Linnæus.



Text figure 6. *Mitrella scripta* (Linnæus), Recent specimen in the Oldroyd Collection at Stanford University; magnification, × 6.

Alia H. and A. Adams can not be separated generically from *Mitrella* Risso, a fact which will be evident to anyone comparing *M. scripta* with *M. carinata* and its varieties. *Mitrella carinata* (Hinds) was designated the type of *Alia* by Cossmann (1901). It is the common, carinated, Pleistocene and Recent Pacific coast species, grading insensibly in large series into variety *hindsii* with the carina partly developed and finally into variety *gausapata* with no sign of a carina.

The variation from a strongly shouldered variety, like typical *carinata*, into a perfectly smooth form, like variety *gausapata*, illustrates the uselessness of such characters for generic or subgeneric distinctions in this group. If *Alia* were used for the carinated section of *Mitrella* and *Mitrella*, *s. s.*, for the smooth group, the arrangement would require placing a species in a different section from its variety.

On plate 10 of volume 5 of his Essais, Cossmann has figured *Mitrella scripta* (Linnæus) and "*Columbella* (*Alia*) *curta* (Dujard.)," both from well-preserved fossil specimens. The reader will note that these two species are placed in different genera. If M. Cossmann had had available a large series of the Pacific coast *M. carinata* and its varieties, he would have seen the lack of generic distinction between *scripta* and Dujardin's *curta*.

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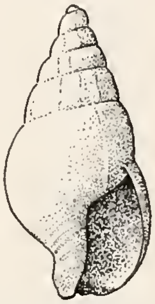
[1] Proc. Zool. Soc. London, p. 138, etc., 1847.

We do not believe it possible to separate *M. gausapata* (Gould) even subgenerically from *M. scripta* on conchological characters, and yet *gausapata* varies insensibly into *carinata*, which is the type of *Alia*. *M. carinata* is very similar to *M. curta* Dujardin, a fact which Cossmann recognized in that he used both species in drawing up his description of *Alia*.

Through the kindness of the conchological staff of the Philadelphia Academy of Natural Sciences, we have been enabled to examine a specimen of *Mitrella rosacea* (Gould), the type of *Astyris*. This species resembles some small, thin specimens of *gausapata*, and the differences do not appear to warrant generic or subgeneric separation. *M. rosacea* differs from *gausapata* by having a thinner, less elongate, and relatively lower spired shell, with a plain outer lip, a wider aperture caused by a decided incurving of the body whorl at the inner lip, a shorter and slightly curved pillar, which is gently constricted at the base of the body whorl, and a larger nucleus and post nuclear whorl.

In the first edition of Gould's[1] "Invertebrata of Massachusetts," "*Buccinum rosaceum* Gould" is illustrated in figure 195, apparently natural size, both apertural and rear views being given. The specimen which we have examined corresponds closely with this figure, except for the nucleus, which is larger. Gould mentions that the shell is "closely covered with minute revolving lines, most conspicuous near the base of the shell, in most parts microscopic." The method of delineation used for Gould's figure was not adapted to illustrating this character properly. On the Academy's specimen these spiral threads are more conspicuous on the basal portion of the body whorl and are entirely absent above the middle of the body whorl. In Binney's edition[2] of Gould's "Invertebrata" a different line drawing of "*Columbella rosacea*" is given. This likewise agrees well with our specimen except for the nucleus. Tryon[3] and Dall[4] have copied this figure. The only other figure which we have seen is that given by Sars[5] who portrays a shell having distinct longitudinal plications on the first three post-nuclear whorls. Sars' specimen, according to the indicated size, was larger than Gould's and may have been a variant. The specimen drawn for the text figure shows very faintly a low axial ribbing on the apical whorls not mentioned by Gould. This axial sculpture indicates the relationship with the axially ribbed genera. *Columbellopsis* Bucquoy, Dautzenberg, and Dollfus is very close to *Mitrella*, *s. s.*, but appears to have a more differentiated anterior canal and a constricted pillar.[6] Cossmann[7] makes it a synonym of *Atilia* H. and A. Adams, because according to him the two names have the same type. However, *C. minor* is not in the Adams' original list and Pace cites the type of *Atilia* as *C. suffusa* Sowerby, a designation which we have accepted although Pace attributed the selection to Chenu (1859), who merely gave it as an example. *C. suffusa* belongs to *Anachis*.[8]



TEXT FIGURE 7. *Mitrella rosacea* (Gould), Recent specimen, No. 16910 in the Academy of Natural Sciences of Philadelphia, collected in Maine by J. S. Phillips, loaned by Pilsbry and Vanatta; magnification, × 6.

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[1] Gould, A. A., "A Report on the Invertebrata of Massachusetts," p. 311, fig. 195, 1841.

[2] Gould, A. A.: "Report on the Invertebrata of Massachusetts," Second Edition, comprising the Mollusca, edited by W. G. Binney, 1870, p. 357, text figure 627 (given as Fig. 195 under species heading).

[3] Tryon, Man. Conch., Ser. 1, Vol. 5, pl. 56, fig. 78, 1883.

[4] Dall, Bull. 37, U. S. Nat. Mus., pl. 69, fig. 1*a*, 1889.

[5] Sars, G. O. Mollusca Regionis Arcticæ Norvegiæ, pl. 16, fig. 1, 1878.

[6] Woodring, Carnegie Inst., Publ. No. 385, p. 274, 1928.

[7] Ess. Paléo. Comp., Vol. 4, p. 242, 1901.

[8] Bucquoy, Dautzenberg, and Dollfus, in their Moll. Mar. Roussillon, Vol. 2, p. 766, 1898, state that *Tetrastomella* Bellardi and their own *Columbellopsis* (Vol. 1, p. 77, 1882) are synonyms of *Atilia*. However, a study of the type species makes *Atilia* a synonym of *Anachis* and *Columbellopsis* a synonym of *Mitrella*.

Angulatomitrella Sacco[1] and *Arcuatomitrella* Sacco[2] are given by Cossmann as synonyms of *Mitrella, sensu stricto.* Cossmann's figure[3] of *C. præcedens* Bellardi, the type of *Arcuatomitrella,* seems to place that shell in *Mitrella, s. s.*

Alcira elegans H. Adams,[4] an African species, is somewhat similar to *Mitrella scripta;* but Adams' species has a thinner shell, a sharp, slightly expanded outer lip without thickening or denticulations, and a small plication on the margin of the columella. *Alcira* H. Adams may be considered a synonym of *Mitrella.* The differences are not more than specific.

Section Mitrella, s. s.

Spiral sculpture confined to basal portion of body whorl.

Mitrella carinata (Hinds)

Plate 26, Figure 35

Columbella carinata Hinds, Voy. Sulphur, Zool., Vol. 2, p. 39, pl. 10, figs. 15, 16, 1844; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 206, 231, 341, 349, 351, 1857; Reeve, Conch. Icon., Vol. 11, *Columbella,* sp. 121, pl. 21, fig. 121, 1858; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 537, 662, 665, 1864; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 116, figs. 35, 39, 1883; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 213, 1892; Wood, Nautilus, Vol. 7, p. 72, 1893; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 232, 1901; Pace, Proc. Malac. Soc. London, Vol. 5, p. 64, 1902; Lowe, Nautilus, Vol. 18, p. 19, 1904; Keep, West American Shells, p. 186, 1904; Gripp, Nautilus, Vol. 22, p. 134, 1909; Dall, Vol. 30, p. 29, 1916; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, p. 12, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Columbella hindsii Reeve, Conch. Icon., Vol. 11, *Columbella,* pl. 23, sp. 143, figs. 143*a-b*, 1858; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 537, 1864; Gripp, Nautilus, Vol. 22, p. 134, 1909.

? *Columbella collaris* Reeve, Conch., Icon., Vol. 11, *Columbella,* sp. 164, pl. 26, fig. 164, 1859.

Columbella ? var. *hindsii* Reeve, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 638, 662, 1864.

Amycla carinata Hinds, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 76, 1868.

Astyris gausapata var. *carinata* Hinds, Keep, West Coast Shells, p. 35, 1888, 1892.

Columbella (*Amycla*) *carinata* Hinds, Wood and Raymond, Nautilus, Vol. 5, p. 57, 1891.

Astyris carinata, var. *hindsii* Reeve, Baker, Nautilus, Vol. 16, p. 40, 1902.

Columbella (*Astyris*) *gausapata* Gould, var. *carinata* Hinds, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 240, pl. 10, fig. 10, 1903.

Columbella gausapata var. *carinata* Hinds, Berry, Nautilus, Vol. 21, p. 41, 1907.

Columbella (*Astyris*) *carinata* Hinds, Orcutt, Molluscan World, Vol. 1, p. 18, 1915.

Columbella carinata var. *hindsii* Reeve, Dall, Nautilus, Vol. 30, p. 26, 1916.

Columbella gausapata carinata Hinds, Chace, Nautilus, Vol. 31, p. 103, 1918.

Columbella (*Alia*) *carinata* Hinds, Dall, U. S. Nat. Mus., Bull. 112, p. 104, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 272, 1927.

Columbella (*Alia*) *carinata hindsi* (Gaskoin) Reeve, Dall, Bull. 112, U. S. Nat. Mus., p. 104, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 272, 1927.

Shell small, elongate to short-ovate, spire varying from rather long, tapering, slightly carinated, to short and strongly keeled below the suture; whorls slightly ventricose to strongly tabulated below the suture; sutures distinct; sculpture lacking except for faint spiral threads on the base of the body whorl, even these obsolete on some specimens; aperture one-third to one-half of the length of the shell, ovate to elongate-ovate and subquadrangular; outer lip generally thickened, with denticulations on the inner side, gently curving or angulated at the shoulder of the body whorl; inner lip a thin callus on the columella; columella tapering somewhat toward the base; anterior canal scarcely set off from the aperture, short; operculum varying from Fusoid to Purpuroid. Length up to 12 mm.

Type specimen: In the British Museum (?).

Type locality: San Diego, California, Recent.

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[1] Type cited by Pace, Proc. Malac. Soc. London, Vol. 5, p. 41, 1902, *C. complanata* Bellardi.

[2] Type, *C. præcedens* Bellardi, *fide* Pace, *op. cit.*, p. 41.

[3] Ess. Paléo. Comp., Vol. 4, pl. 10, figs. 4, 5, 1901.

[4] Proc. Zool. Soc. London for 1860, p. 451, monotype of *Alcira* H. Adams, *op. cit.*, p. 450.

Pliocene: Santa Barbara formation (upper Pliocene) at Bath-house Beach, Santa Barbara, (Gabb; Arnold): upper Pico between Timber Canyon and Santa Paula Creek, Ventura County, S. D. S. N. H. loc. 225, one specimen.

Pleistocene: All Pleistocene localities at San Pedro, Los Angeles Co., common (Arnold); lower San Pedro series of Nob Hill cut, Los Angeles Co., plentiful (T. S. Oldroyd); palisades north of Santa Monica, Los Angeles Co. (F. C. Clark collection); Spanish Bight, San Diego Co. (Arnold; Mrs. K. Stephens); lower Quaternary at Magdalena Bay, Lower California, Mexico (E. K. Jordan); Pleistocene of irrigation ditch north of Ventura (Arnold); Los Posas formation, S. D. S. N. H. loc. 233, north of Arroyo Santa Rosa, Ventura County, common (U. S. G.).

Recent: San Francisco Bay, California, to Cape San Lucas, Lower California, Mexico.

This species is quite variable in the development of the carina or shoulder on the upper part of the body whorl. Some specimens are strongly carinated on the margin of the tabulation, while others intergrade with the variety which has only a sloping tabulation extending part way around the body whorl. This latter form has been separated as variety *hindsii,* which we consider a useless distinction leading to confusion. In fact, there is complete intergradation from the strongly carinated *carinata* to the smoothly rounded *gausapata,* but we retain the two end forms varietally. The carinated forms appear to be more common in warmer water and represent a later evolutionary tendency than *gausapata.*

This species is a common Recent shell in shallow water along the southern California coast. It appears to be more abundant in the bays and lagoons than on the open coast.

Mitrella carinata (Hinds) variety **gausapata** (Gould)

Plate 26, Figure 44

Columbella gausapata Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 170, 1851; U. S. Exploring Exped., Vol. 12, p. 267, 1852, Atlas, Mollusca, figs. 337, 337*a-b*, 1856; Tryon, Man. Conch., Ser. I, Vol. 5, p. 116, 1883; Keep, West American Shells, p. 186, 1904; Berry, Nautilus, Vol. 21, p. 41, 1907; Smith, p. 58, 1907; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 593, 596, 1913; T. S. Oldroyd, Nautilus, Vol. 28, p. 82, 1914; Dall, Vol. 30, p. 26, 1916; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93, 1922; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Columbella californiana Gaskoin, Proc. Zool. Soc. London for 1851, p. 12, 1852; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 341, 1857; not *Columbella californica* Reeve, Conch. Icon., Vol. 11, *Columbella,* sp. 165, fig. 165, 1859, a Japanese species *fide* Nautilus, Vol. 26, p. 76, 1912.

Nassa pedroana Conrad, Pacific R. R. Repts., Vol. 5, p. 327, pl. 6, fig. 48, 1856.

Amycla gausapata Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 662, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 76, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 229, 1888.

Columbella (Alia) richthofeni Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 10, pl. 2, fig. 16, 1866.

Columbella richthofeni Gabb, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 236, 1888.

Astyris gausapata Gould, Keep, West Coast Shells, p. 35, fig. 15, 1888, 1892; Baker, Nautilus, Vol. 16, p. 40, 1902.

Columbella (Astyris) gausapata Gould, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 213, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 239, in part, but not pl. 10, fig. 8 (= *M. gouldii* Carpenter), 1903.

Columbella (Astyris) californiana Gaskoin, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 238, pl. 10, fig. 9, 1903.

Astyris richthofeni Gabb, Arnold, Proc. U. S. Nat. Mus., Vol. 34, pl. 36, fig. 8, 1908; Bull. 396, U. S. Geol. Surv., p. 156, pl. 25, fig. 1, Jan. 15, 1910; Bull. 398, pl. 47, same figure, 1910.

Columbella (Alia) carinata californiana Gaskoin, Dall, Bull. 112, U. S. Nat. Mus., p. 104, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 273, 1927.

Columbella (Alia) gausapata Gould, Dall, Bull. 112, U. S. Nat. Mus., p. 104, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 273, 1927.

Shell small, light in weight, elongate-ovate, spire high, apex acute; whorls five or six, very slightly ventricose, regularly enlarging; sutures linear, depressed; sculpture obsolete except for faint spiral striæ on the base of the body whorl; aperture less than one-half the length of the entire shell, elongate ovate or slightly subquadrate; outer lip denticulated within, on some specimens marked by an incipient flare or shoulder at the posterior junction with the body whorl; inner lip with a thin callous wash, gently curving; columella short, sometimes abruptly, obliquely truncated at the base and with small plications near the base; anterior canal not differentiated from the anterior portion of the aperture, which is ample; size, up to 13 mm. in length; 5 mm. in width; average considerably smaller.

Type specimens: Of *californiana*, in the Cuming Cabinet, British Museum ?; of *richthofeni*, unknown; of *gausapata*, in the collection of the Boston Society of Natural History.

Type localities: Of *californiana*, San Diego, California, Recent; of *gausapata*, Puget Sound, Recent; of *richthofeni*, Pliocene of middle California.

Miocene: Montesano formation, upper Miocene of Chehalis County, Washington (Weaver).

Pliocene: Coos conglomerate, Oregon, Pliocene (Howe); Russian River, Sonoma County, Seven Mile Beach, San Mateo County (Gabb, Cooper); San Fernando, Los Angeles County (Cooper); upper Sargent, Purisima, and lower Merced formations (Nomland); Kirker's Pass (Cooper); upper part of Etchegoin formation, Coalinga region (Arnold); Santa Barbara formation at Bath-house Beach, Santa Barbara (Arnold); lower part of Merced formation, Seven Mile Beach, San Mateo County (coll. by Geo. H. Ashley); Purisima formation at San Gregorio, San Mateo County; Purisima of New Year Point (Pt. Año Nuevo) San Mateo County; Twelve Mile Creek, San Mateo County (Arnold and Hannibal); Elk River formation (upper Pliocene), mouth of Elk River, Oregon.

Pleistocene: All Pleistocene localities in the vicinity of San Pedro, Los Angeles County (Arnold); lower San Pedro fauna, Nob Hill cut, San Pedro, plentiful (T. S. Oldroyd): "old irrigation ditch north of Ventura and at Barlow's Ranch, Ventura County" (Arnold); Pacific Beach and foot of 26th Street, San Diego (Palos Verdes formation ?) (Arnold; Mrs. K. Stephens); Los Cerritos (now Signal Hill), (Palos Verdes formation) (T. S. Oldroyd); late Pleistocene of Santa Monica (in Oldroyd Collection at Stanford University), and palisades north of Santa Monica (collection of F. C. Clark); upper Pleistocene of San Quintin Bay, Lower California, Mexico (E. K. Jordan); Pleistocene, locality 233 S. D. S. N. H. north of Arroyo Santa Rosa, Ventura Co. (U. S. G.); Pleistocene terrace on the coast about 8 miles northwest of Ventura, S. D. S. N. H. loc. 78 (U. S. G.).

Recent: Forrester Island, Alaska, to Salina Cruz, Mexico.

A study of a series of specimens of *Mitrella gausapata* from its type locality and a comparison with numerous specimens of *californiana* show that these two names have been applied to the same species. The original figure and description of *Nassa pedroana* Conrad conforms well with *gausapata* and could scarcely be any other species. It is certainly not a *Nassarius*. Gabb's *Columbella richthofeni* cannot be separated from *gausapata* by Gabb's description or figure, and the type specimen is probably lost.[1] Gabb's figure illustrates a shell about half an inch long; but Gould's type of *gausapata* was given as a half inch long also. The specimens are unusually large. Arnold[2] figured as *Astyris richthofeni* a *Mitrella* from the upper part of the Etchegoin formation of the Coalinga region which represents a slightly distorted *gausapata*. Arnold's figure of *gausapata* in the San Pedro Memoir (pl. 10, fig. 8) indicates a low carina on the base of the body whorl which suggests that it represents *M. gouldii* (Carpenter). Arnold's figure of *californiana* (pl. 10, fig. 9) represents a typical *gausapata*.

Mitrella kirkensis (Clark), described from the lower San Pablo group (upper Miocene) near Kirker's Pass, Contra Costa County, is a related species, but differs in having a longer and more slender canal. It is said to have sometimes a distinct shoulder on the upper part of the body whorl similar to the shoulder found on forms intermediate between typical *carinata* and variety *gausapata*. It is probably the ancestor of the *carinata-gausapata* group. It is not clearly related to *M. tenuilineata* (Clark) from the Oligocene.

"Amycla" communis Conrad,[3] a *Mitrella* from the Miocene of New Jersey, is somewhat similar to *M. gausapata* in general appearance, to judge from Whitfield's figures.[4]

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[1] Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 291, 1926.

[2] U. S. Geol. Surv., Bull. 376, pl. 25, fig. 1, 1909.

[3] Conrad, T. A., Proc. Acad. Nat. Sci. Phila. for 1862, pp. 287, 564.

[4] Whitfield, R. P., Mon. 24, U. S. Geol. Surv., pl. 29, figs. 12-15, 1894.

Mitrella gouldii (Carpenter)

"*? Nitidella*" *gouldii* Carpenter, Proc. Zool. Soc. London for 1856, p. 208, 1857.

Not *Columbella gouldii* Agassiz MS., Reeve, Conch. Icon., Vol. 11, *Columbella*, sp. 135, Nov., 1858.

Nitidella gouldii Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 663, 1864; Dall, Bull. 112, U. S. Nat. Mus., p. 104, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, p. 12, Jan., 1924; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 98, March, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. I, p. 277, 1927.

Columbella (*Nitidella ?*) *dalli*, E. A. Smith, Ann. Mag. Nat. Hist., Ser. 5, Vol. 6, p. 287, 1880.

Astyris gouldi Carpenter, Baker, Nautilus, Vol. 16, p. 40, 1902.

Nitidella gouldi Carpenter, Dall, Nautilus, Vol. 30, p. 26, 1916.

Columbella (*Astyris*) *constantia* Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 53, pl. 1, figs. 7*a*, 7*b*, Oct., 1916.

Type specimens: Of *gouldii*, in the Gould collection (Albany ?); of *dalli*, in the British Museum; of *constantia*, at the University of California.

Type localities: of *gouldii*, Santa Barbara, California, Recent; of *dalli*, Vancouver Island, British Columbia, Recent; of *constantia*, Fourth Street and Broadway, Los Angeles, California, upper Pliocene.

Pliocene: "Fernando" of Fourth and Broadway, Los Angeles, upper Pliocene (Moody); Capitola, Monterey Co. (collection at Stanford University).

Pleistocene: Lower San Pedro fauna (lower Pleistocene) of Nob Hill cut, San Pedro (I. S. Oldroyd).

Recent: Kodiak, Alaska, to San Diego, California.

This species is similar to *M. carinata* var. *gausapata* (Gould) in shape; but the body whorl is somewhat more ventricose just above its base, the spire is usually relatively lower, and the denticulations on the inner side of the outer lip are apt to be deeper within the aperture and are frequently absent altogether. It is comparatively large and thin-shelled. The anterior canal is more clearly differentiated from the aperture than in *gausapata*. While these two species are similar in general appearance, they can usually be separated by these characters. When specimens of *gouldii* are held so that a strong light falls directly upon the spire, a shadow begins abruptly on the lower portion of the body whorl and brings out the low carina in that region.

Columbella constantia Moody, described from the upper Pliocene of Los Angeles, is undoubtedly *M. gouldii*. We have examined the type specimen. Specimens with an incomplete outer lip appear to have an unusually long anterior canal, and this imperfection in fossils is frequently quite misleading. The specimens collected by T. S. Oldroyd from the Pleistocene of Nob Hill, San Pedro, California, are rather small in comparison with recent specimens from Alaska, some of which reach 15 mm. in length.

The margin of the oblique truncation on the lower part of the columella of *gouldii* has a small, low ridge or marginal plait which is unlike the plication on the columella of typical *Nitidella nitida* (Lamarck), and *gouldii* is probably not genetically related to *Nitidella*. The shape of the entire shell and particularly the oval aperture require its being placed with *Mitrella*.

The collections at Stanford University contain a considerable number of specimens of *Mitrella*, labeled *Astyris gausapata* Gould, *A. richthofeni* Gabb, and *Columbella richthofeni* Gabb from the Merced and Purisima formations (Pliocene) of San Mateo County, California, and from the upper Pliocene of the mouth of Elk River, Oregon. Most of these specimens can be classified as *Mitrella carinata* var. *gausapata* (Gould), but some have the characters of *Mitrella gouldii* (Carpenter). It appears probable that *M. gouldii* separated from *gausapata* in the late Pliocene, the collections suggesting that the *gouldii* form occurred as individual mutants or variants along with the parent stock of *gausapata*. The separation of the two forms is difficult in the Pliocene, and when the specimens are imperfect distinction is impossible.

Mitrella grandior, new species

Plate 26, Figure 46

Shell large, heavy, elongate, spire high; whorls about five, slightly ventricose; sutures linear, slightly depressed; sculpture absent except for a few faint, low, wide spiral cords on the base of the body whorl; aperture less than half the length of the entire shell, elongate-ovate; outer lip (incomplete) simple, no flare or shoulder at the posterior end; inner lip with a slight callus deposit on the columella; columella (incomplete) nearly straight, without denticulations; anterior canal missing on the type. Length (incomplete), 22 mm.; width, 9.5 mm.

Type specimen: No. 6, Invertebrate Paleontology Collection, San Diego Society of Natural History, San Diego, California.

Type locality: San Diego Society of Natural History locality 221, second conglomerate ridge on the east side of Cañada de Aliso, north of Cañada Larga about one-quarter mile, Ventura County, California, middle (or upper ?) Pico, Pliocene, collected by H. R. Gale.

Pliocene: Type locality only, middle (or upper Pico); one specimen.

The high spire, ovate aperture, and lack of sculpture except on the base of the body whorl in back place this species in *Mitrella*. It is very much larger and heavier than types of *gausapata* and *richthofeni*, both of which were said to be a half inch in length. Gabb's largest specimen of *richthofeni*[1] was "about .5 inch."

We have examined several hundred fossil specimens of the *gausapata* group in the collections at Stanford University and while the average length is considerably less than a half inch, two or three specimens of *gausapata* approximate that size. There were none over half an inch long.

M. grandior appears to resemble very closely *M. erythrostoma* (Bonelli),[2] an extinct European species occuring in the Red Crag (upper middle Pliocene) of England and the Pliocene of Italy. The latter species is well figured by Harmer[3] in his monograph on the Crag mollusca. The chief difference between the two species is that *M. grandior* has a proportionately larger body whorl. In *grandior* the enlargement of successive whorls appears to have been suddenly accelerated when the ultimate whorl was reached, whereas the Crag species shows a more uniform enlargement during growth. These differences in some species are within the limits of individual variation.

Mitrella ocellata (Gmelin)

Voluta ocellata Gmelin, Syst. Nat., Ed. 13, p. 3455, 1791.

Buccinum cribrarium Lamarck, Hist. Nat. Anim. s. Vert., Vol. 7, p. 274, 1822.

Columbella guttata G. B. Sowerby, Proc. Zool. Soc. London for 1832, p. 118, *fide* Sowerby, Thes. Conch., Vol. 1, *Columbella*, p. 129, 1844; not of G. B. Sowerby, Proc. Zool. Soc. London for 1844, p. 50, = *C. punctata* Sowerby, 1844 (= ? *C. fasciata* Sby.); C. B. Adams, Ann. Lyc. Nat. Hist. N. Y., Vol. 5 (p. 89 of the separate), 1852.

Columbella cribraria Lamarck, Sowerby, Thes. Conch., Vol. 1, *Columbella*, p. 129, sp. 51, pl. 38, fig. 112 (113 *jun.*), 1844; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 122, pl. 48, figs. 73-77, 1883.

Columbella argus A. d'Orbigny (d'Orb., 1840) in Sagra, Hist. Isla Cuba, Pt. 2, Vol. 5, pp. 233, 234, pl. 21, figs. 34, 36, 1845.

Buccinum parvulum Dunker, Zeit., für Mal., p. 64, 1847.

Nitidella cribraria Lamarck, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 487, 1857.

Nitidella ocellata Gmelin, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 217, 1909; Nautilus, Vol. 30, p. 26, 1916; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Nitidella crebraria Gmelin, Zetek, Moll. Rep. Panama, p. 23, 1918 (= *N. cribraria* Lamarck).

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[1] Geol. Surv. Calif., Palæo., Vol. 2, p. 10, 1866, figured on pl. 2, fig. 16.

[2] *Columbella erythrostoma* Bonelli, MS. Cat. Mus. Zool. Torino, 1825; Bellardi, Mon. Columbelle, p. 9, pl. 1, figs. 4, 5, 1848.

[3] Mon. Palæo. Soc., Vol. 70, Plio. Moll. Gt. Brit., Vol. 1, pt. 3, p. 306, pl. 33, figs. 11, 12, 1918; also figured by Cerulli-Irelli, Palæo. Ital. Vol. 17, p. 256, pl. 23, figs. 64, 64*a*, 1911.

Shape like that of *M. carinata gausapata* (Gould) but with thicker, heavier shell and with the pillar often a little longer than the anterior margin of the outer lip and lacking the small crenulations or denticulations that are sometimes present on *gausapata;* the apex sometimes (or always ?) blunt.

Pleistocene: "Upper Quaternary" at San Ignacio Lagoon, Lower California, Mexico (E. K. Jordan).

Recent: Magdalena Bay, Lower California, to Guayaquil, Ecuador, and the Galapagos; West Indies.

There has been uncertainty over the recognition of Gmelin's species, as the type specimen and the type locality are both unknown. Tryon, Dall, and others have considered Lamarck's *Buccinum cribrarium* conspecific. This name was applied by Lamarck to a species reputed to have come from Java, and it seems doubtful if that same species occurs also in the West Indian and west American regions without showing some varietal differences. Under the circumstances, we have used the oldest name for the American species.

Mitrella tuberosa (Carpenter)

Plate 26, Figure 45

Amycla tuberosa Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 539, 628, 662, 1864; Annals and Mag. Nat. Hist., Ser. 3, Vol. 15, p. 398, May, 1865; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 229, 1888.

Astyris tuberosa Carpenter, Stearns, Proc. Calif. Acad. Sci., Vol. 5, p. 81, 1873; Keep, West Coast Shells, p. 36, 1888, 1892; Kelsey, Nautilus, Vol. 12, p. 89, 1898; Baker, Vol. 16, p. 40, 1902.

Columbella tuberosa Carpenter, Tryon, Man. Conch., Ser. 1, Vol. 5, p. 135, pl. 50, figs. 40, 41, 1883; Lowe, Nautilus, Vol. 18, p. 19, 1904; Berry, Vol. 21, p. 41, 1907; Vol. 22, p. 38, 1908; T. S. Oldroyd, Vol. 28, p. 82, 1914; Willett, Vol. 33, p. 22, 1919; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 271, 1927.

Columbella (Astyris) tuberosa Carpenter, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 213, pl. 20, fig. 6, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 240, pl. 10, fig. 7, 1903; Keep, West American Shells, p. 187, 1904.

Columbella (Alia) tuberosa Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 103, 1921.

Columbella (Alia) tuberosa var. *major* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, pp. 12, 24, 1924; not *Columbella major* Sowerby, 1832; nor *Columbella scripta* (Linnæus) var. *major* Monterosato, Giorn. Soc. Palermo, Vol. 13, p. 104, 1878; nor *Columbella rustica* (Linnæus), var. *major* Pallary, 1900.

Shell like that of *gausapata* but smaller, more elongate, with relatively higher, more slender spire, and with a low carina or angle just below the middle of the body whorl.

Type specimens: Of *tuberosa,* in the British Museum ?; of *major,* in the U. S. National Museum, No. 352,369.

Type localities: Of *tuberosa,* Santa Barbara, Recent; of *major,* lower Pleistocene of Nob Hill cut, San Pedro, Los Angeles County, California.

Miocene: Doubtfully in the San Pablo formation, upper Miocene of California, (Clark); Superior Oil Company's well, Ansolabehere No. 1, four or five miles north of Bakersfield, depth 4,525 feet, Santa Margarita formation, upper Miocene (H. R. G.).

Pliocene: San Diego well in Balboa Park, San Diego, San Diego formation, middle Pliocene (Dall; Arnold); Bath-house Beach, Santa Barbara, Santa Barbara formation, upper Pliocene (Berry); upper Pliocene (Santa Barbara zone) at loc. 218 S. D. S. N. H., Sulphur Canyon, east of South Mt., Ventura Co. (H. R. G.).

Pleistocene: Lower San Pedro fauna at Deadman Island and San Pedro, rare; in upper San Pedro fauna at Crawfish George's, Los Cerritos (Signal Hill), San Pedro, and Deadman Island, Los Angeles Co.; Spanish Bight, San Diego, upper San Pedro fauna, (Arnold); lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd, as var. *major*); upper San Pedro fauna of Los Cerritos, (T. S. Oldroyd); San Quintin Bay, Lower California, upper Pleistocene (E. K. Jordan); S. D. S. N. H. loc. 233, north of Arroyo Santa Rosa, Ventura Co., lower Pleistocene, not rare (U. S. G.).

Recent: Alaska to Gulf of California, Mexico (Dall).

This species is readily recognized by the high spire and angulated periphery on the lower part of the body whorl. It resembles *Mitrella borsoni* Bellardi, of the Italian Miocene, to judge from Harmer's figure of that species in the Monograph of the Crag Mollusca.[1] The northern cool-water specimens are larger than the southern ones, and Oldroyd has separated the large forms as variety *major.* This name is preoccupied several times.

Section STRIOMITRELLA, new section

Type: Buccinum sulcatum J. Sowerby, Min. Conch. Gt. Brit., Vol. 4, p. 103, pl. 375, fig. 2, 1823; Vol. 5, p. 122, pl. 477, fig. 4, 1825; British Crag fossil (Pliocene); figured also by Harmer, Mon. Palæo. Soc., Vol. 70, Plio. Moll. Gt. Brit., Vol. 1, pt. 3, p. 307, pl. 33, fig. 14, Feb., 1918; Nyst, Ann. Mus. Roy. Hist. Nat. Belg., Sér. Paléo., Vol. 3, p. 36, pl. 3, fig. 2, 1881 (Scaldisien of Belgium).

Entire exterior surface of shell with spiral sculpture.

Mitrella sulcata (J. Sowerby), a spirally sculptured Pliocene and Pleistocene species of the Anglo-Belgian region of Europe, appears to be sufficiently distinct from those Mitrellas with the spiral sculpture confined to the basal portion of the body whorl to warrant sectional separation from *Mitrella, s. s.*

Thesbia was proposed by Jeffreys[2] for a spirally striate group of *Columbella;* but the type, *Thesbia nana* (Lovén), belongs to the *Turridæ,* and hence *Thesbia* cannot be used here.

The type of *Striomitrella* is an extinct species which occurs in the Pliocene and middle glacial sands of Great Britain and in the Scaldisien (upper Pliocene) of Belgium. *Mitrella tenuilineata* (Clark),[3] of the San Lorenzo Oligocene of Contra Costa County, California, belongs to this group. Clark's species has been poorly figured. It has a small, elongate shell with definite spiral sculpture over the entire surface.

Genus STROMBINA Mörch, 1852

Strombina Mörch, Cat. Yoldi, p. 85, 1852; Pace, Proc. Malac. Soc. London, Vol. 5, no. 1, p. 43, April, 1902; list includes *S. lanceolata* Sby. and *S. gibberula* Sby.

Strombocolumbus Cossmann, Ess. Paléo. Comp., Vol. 4, p. 241, 1901; type, *S. lanceolata* Sowerby.

Type (by subsequent designation, Cossmann, 1901), *S. lanceolata* Sowerby, 1832.

Shell rather thick, elongate, with a high, sharp spire; apex acute; body whorl about half the length of the shell; whorls about eight, gibbous and nodulose; sutures slightly impressed; sculpture consisting of strong, protuberant, rounded nodes and very faint spiral threads on the basal portion of the body whorl; aperture narrow, elongate, sinuous; outer lip thickened externally and also in typical examples thickened internally in the middle, sometimes with faint teeth on the thickened part; inner lip reinforced by a callus deposit extending some distance from the aperture, but the polish on the callus ending sharply nearer the aperture; anterior canal well formed, somewhat reflected; posterior canal undeveloped. Average height of type, about 30 mm.

Geologic range: Eocene (*fide* Cossmann, 1901) to Recent.

Distribution: Warm seas of west American coasts.

Strombocolumbus was proposed by Cossmann as a substitute for *Strombina,* under the misapprehension that Mörch's name had been preoccupied by Bronn, who, however, used it for a group of genera[4] and not as a part of a binomial name. The type of *Strombocolumbus, S. lanceolata,* Sowerby, being in the original list of species under *Strombina,* becomes the type of the latter genus.

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[1] Mon. Palæo. Soc., Vol. 70, Plio. Moll. Gt. Brit., Vol. 1, pl. 33, fig. 21, 1918.

[2] Brit. Conch., Vol. 4, p. 359, 1867, monotype *Tritonium ? nana* Lovén, Ind. Moll. Scand., p. 12, 1846; type figured and described by Sars, Moll. Reg. Arct. Norv., p. 221, pl. 16, fig. 2, 1878; Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 461, 1853; Vol. 4, pl. 112, fig. 8, 1853.

[3] Univ. Calif. Publ. Geol., Vol. 11, p. 173, pl. 22, figs. 2, 3, 1918.

[4] *Fide* Pace, Proc. Malac. Soc. London, Vol. 5, no. 1, p. 43, 1902.

Strombina maculosa (Sowerby)

Columbella maculosa Sowerby, Proc. Zool. Soc. London for 1832, p. 116; Reeve, Conch. Icon., Vol. 11, *Columbella*, pl. 4, sp. 19, figs. 19*a*, 19*b*, 1858; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 186, pl. 60, fig. 97, 1883; not of Pease, 1871.

Strombina maculosa Sowerby, Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Type specimen: In the British Museum.

Type locality: Guacamayo, Central America.

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna & Hertlein, 1927).

Recent: Cape San Lucas, Lower California, Mexico, to Central America; common in Gulf of California (A. M. Strong).

This is the only reported Pliocene occurrence of *Strombina* on the Pacific coast of North America. Woodring[1] reports several species of *Strombina* in the Caribbean Miocene, but states that the genus is now extinct in Atlantic waters. No species of *Strombina* has been reported in strata older than Pliocene on the Pacific coast of North America.

Strombina gibberula (Sowerby)

Columbella gibberula Sowerby, Proc. Zool. Soc. London for 1832, p. 115; Sowerby, Thes. Conch., Vol. 1, *Columbella*, sp. 76, p. 136, pl. 39, figs. 142, 143, 1844; Reeve, Conch. Icon., Vol. 11, *Columbella*, pl. 13, sp. 61, figs. 61*a*, 61*b*, 1858; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 184, pl. 60, fig. 90, pl. 63, fig. 71, 1883; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 217, 1909.

"*Columbella gibbosula* Broderip," d'Orbigny, Voy. Amér. Mérid., Vol. 5, pt. 3, p. 430, 1841, *fide* Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 282, 1909.

Strombina gibberula Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 282, 1909.

Type specimen: In the British Museum.

Type locality: Unknown. Hab. "Bay of Caraccas and Puerto Portrero."

Pleistocene: San Ignacio Lagoon, Lower California, Mexico (Oldroyd Coll. Stanford University, five specimens).

Recent: Lower California to Peru (A. M. Strong).

This small species of *Strombina* is peculiar in having varix-like swellings on the body whorl caused by periodic thickening of the outer lip. The thickening on the exterior of the outer lip is prominent and there are two earlier thickenings on the body whorl, one on the left margin of the body whorl as viewed from the apertural side, and one on the back of the body whorl, the latter being like a nodosity on the shoulder of the whorl. The body whorl is large and shouldered, the sharp, narrow spire terminating in an acute apex.

The largest fossil specimen in the Oldroyd Collection is 11 mm. in length.

Strombina recurva (Sowerby)

Plate 26, Figures 38, 41

Columbella recurva Sowerby, Proc. Zool. Soc. London for 1832, p. 115, 1832; Thes. Conch., Vol. 1, *Columbella*, p. 139, pl. 40, fig. 152, 1844; Reeve, Conch. Icon., Vol. 11, pl. 4, figs. 18*a*, 18*b*, 1858.

Strombina recurva Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 219, 1909; Dall and Ochsner, Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 96, 1928.

Shell of moderate size, high spired, with rounded axial nodes on upper part of body whorl, becoming sharper on upper whorls; a few spiral threads on base of body whorl, outer lip greatly thickened, denticulate within; anterior canal notched.

Dimensions: Height, 26 mm.; height of body whorl, about 15 mm.; diameter of body whorl, including thickened outer lip, 10 mm.

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[1] Carnegie Inst., Publ. No. 385, pp. 282-5, 1928.

Type specimen: In the British Museum.

Type locality: La Plata Island, Ecuador; Recent.

? Pleistocene: Old beach deposit north of Turtle Cove on Albemarle Island, Galapagos Islands (Dall and Ochsner; Stanford Collection).

Recent: Central America to Guayaquil (Dall, 1909).

This handsome species is strongly noded and has a gibbous body whorl. The base of the body whorl has a few revolving threads. *S. gibberula* is smaller and lacks the strong nodosities of this species. *S. maculosa* is smaller, has a less thickened outer lip, a less recurved anterior canal, and the sculpture is somewhat different.

The Albemarle Island fossil bed described by Dall and Ochsner may be late Quaternary in age.

The following species of *Strombina* occur in the Recent Pacific coast fauna south of San Diego, California, according to A. M. Strong:

S. angularis Sowerby, 1832. Panama.
S. colpoica Dall (*subulata* Sby., 1849, not Duclos, 1840). Gulf of California.
S. dorsata Sowerby, 1832. Panama to Guayaquil.
S. edentula Dall. Gulf of California to Panama.
S. elegans Sowerby, 1832. Central America.
S. fusinoidea Dall (*fusiformis* Hinds, 1844, not Anton, 1839, nor d'Orbigny, 1844). Central America.
S. gibberula Sowerby, 1832. Lower California to Peru.
S. lanceolata Sowerby, 1832. Panama to Peru.
S. lilacina Dall. Gulf of California.
S. maculosa Sowerby, 1832. Gulf of California to Central America.
S. paceana Dal . Gulf of California.
S. pavonina Hinds, 1844. Panama.
S. pulcherrima Sowerby, 1832. Central America.
S. recurva Sowerby, 1832. Central America to Guayaquil.
S. turrita Sowerby, 1832. Nicaragua to Ecuador.

Genus AMPHISSA H. and A. Adams, 1853

Amphissa H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 111, 1853, list includes only *corrugata* Reeve and *intincta* Reeve; Dall, Amer. Journ. Conch., Vol. 7, p. 111, 1871, "Type *Amphissa corrugata* H. and A. Adams"; Tryon, Struct. Syst. Conch., Vol. 2, p. 180, 1883, example, *A. corrugata* Rve.; Fischer, Man. Conchyl., p. 638, 1884; example, *A. versicolor* Dall; Cossmann, Ess. Paléo. Comp., Vol. 4, p. 229, 1901, "Type: *Columbella versicolor*, Sow."; Pace, Proc. Malac. Soc. London, Vol. 5, p. 41, 1902; Dall, Proc. U. S. Nat. Mus., Vol. 45, p. 589, 1913.

Type (designated by Dall, 1913), *Buccinum corrugatum* Reeve, not *Buccinum corrugatum* Brocchi, 1814, = *Amphissa columbiana* Dall.

Shell of moderate size, elongate Buccinoid; nucleus small, spire high, whorls ventricose, suture depressed; sculpture of axial ribs and spiral threads or cords; aperture ovate, slightly subquadrate, about half the length of the entire shell; outer lip sharp or slightly thickened internally and generally with small lirations, gently curving but typically nearly straight for a short distance just above the middle of the aperture; inner lip with a callus wash on the body whorl and pillar; columella nearly straight, with typically a few small, short plaits at about the midpoint of the aperture; anterior canal hardly differentiated from the aperture, which is effuse anteriorly; posterior canal not developed.

Geologic range: Pleistocene to Recent.

Distribution: Northwest coast of North America south to Gulf of California.

This genus is represented on the Pacific coast by half a dozen supposed species and a few varieties. *Amphissa palmeri* Dall, *parvula* Dall, and *pergracilis* Dall are Cosmioconchas which we believe should be generically separated from *Amphissa*.

Amphissa is readily recognized by its elongate Buccinoid shape, spiral and axial sculpture, and the effuse anterior portion of the aperture. It is distinguished from *Buccinum* conchologically by being more elongate, smaller, having less ventricose whorls, narrower aperture, lirations on the inside of the outer lip, and small plaits on the columella. *Nassarius*, with its strong sinus on the base of the body whorl, is quite distinct. *Anachis* does not have the uniform spiral sculpture covering all the whorls of the shell and is generally smaller; nor does its aperture expand anteriorly.

Amphissa is a characteristic Pacific coast genus, extending from Alaska to the Gulf of California but not to the Panamic region. *Cosmioconcha* Dall takes its place in tropical waters.

Amphissa columbiana Dall

Plate 26, Figure 39

Buccinum corrugatum Reeve, Conch. Icon., Vol. 3, *Buccinum*, sp. 10, 1847; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, pp. 211, 342, 1857; Rept. for 1863, pp. 563, 598, 1864, reprinted in Smithsonian Misc. Coll., No. 252, pp. 49, 84 (bottom pagination), 1872; not *Buccinum corrugatum* Brocchi, 1814.

"*Buccinum valga* Gould," W. Cooper, U. S. Pacific R. R. Repts., Suppl. to Vol. 1, pt. 3, p. 373, 1859, not of Gould.

? *Truncaria corrugata* Reeve, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 662, 1864, (possibly = *versicolor* Dall, in part).

Cominella (*Amphissa*) *corrugata* Reeve, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 74, 1868-9.

Amphissa corrugata Reeve, Dall, Amer. Journ. Conch., Vol. 7, pt. 2, pp. 111, 113, pl. 16, fig. 9, 1871; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 197, pl. 63, fig. 66, 1883; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 228, 1888; Keep, West Coast Shells, p. 34, fig. 14, 1888; Ed. 2, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 241, 1903; Keep, West American Shells, p. 188, fig. 191, 1904; M. Smith, Nautilus, Vol. 21, p. 58, 1907; Berry, Vol. 22, p. 38, 1908; Gripp, p. 134, 1909; Baker, Vol. 24, p. 31, 1910; Dall, Vol. 30, pp. 27, 29, 1916; Willett, Vol. 33, p. 23, 1919.

Amphissa columbiana Dall, Nautilus, Vol. 30, p. 27 (*Buccinum corrugatum* Reeve, 1847, not *B. corrugatum* Brocchi, 1814), 1916; Dall, Bull. 112, U. S. Nat. Mus., p. 105, pl. 6, fig. 9, pl. 11, fig. 9, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 280, pl. 16, fig. 3, 1927.

Type specimen: In the British Museum.

Type locality: Puget Sound, (*fide* Oldroyd, 1927).

Pliocene: San Diego formation, San Diego well, Balboa Park, San Diego (Dall, *fide* Arnold, 1903); Deadman Island, San Pedro (Arnold); Santa Barbara formation at Bath-house Beach, Santa Barbara (upper Pliocene), (Berry, 1910).

Pleistocene: Lower San Pedro at Deadman Island, common (Arnold, 1903); "upper San Pedro series" of San Pedro, Los Cerritos (now Signal Hill), and Crawfish George's, Los Angeles County (Arnold, 1903).

Recent: Chiachi Islands, Alaska, to San Pedro, California (Dall, 1921).

This large species has an elongate-Buccinoid shape and is readily distinguished from the other species.

Amphissa ventricosa Arnold

Amphissa ventricosa Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 242, pl. 5, fig. 11, 1903.

"Shell small, broadly fusiform; spire elevated; whorls five or six, evenly convex, with twelve or thirteen strong, rounded, transverse ridges; interspaces sculptured with prominent, regular, equidistant, raised spiral lines, of which there are five or six on the penultimate whorl; suture deeply impressed, distinct; aperture semicircular; outer lip ventricose, thickened with row of teeth; inner lip smooth, incrusted; pillar straight; spirally sculptured on outside; no canal.

"Dimensions: Long. 12 mm.; lat. 6 mm.; body whorl 8.6 mm.; aperture 6 mm.; defl. 43 degrees." (Arnold, 1903.)

Type specimen: In the U. S. National Museum.

Type locality: Deadman Island, San Pedro, Los Angeles County, Pleistocene.

Pleistocene: Rare in the lower San Pedro formation at the type locality, Deadman Island, California.

"Resembles *A. bicolor* somewhat, but distinguishable from this species by lack of canal, stronger ribs, and more convex whorls; distinguishable from other members of genus by thin shell, ventricose whorls, semicircular aperture and lack of differentiated canal." (Arnold, 1903.)

This form is so close to *A. bicolor* Dall in Williamson[1] that it might be more appropriately considered a variety. It is certainly the precursor of Dall's species.

Amphissa versicolor Dall

Plate 26, Figure 53

Amphissa versicolor Dall, Amer. Journ. Conch., Vol. 7, p. 113, pl. 13, fig. 2, pl. 14, fig. 2, pl. 16, figs. 10, 11, 1871; Kelsey, Nautilus, Vol. 12, p. 89, 1898; Baker, Vol. 16, p. 41, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 242, 1903; Berry, Nautilus, Vol. 21, p. 40, 1907; M. Smith, p. 58, 1907; Gripp, Vol. 22, p. 134, 1909 (as of Reeve, in error); T. S. Oldroyd, Vol. 25, p. 74, 1911; Lowe, Vol. 27, p. 28, 1913; Clark, Vol. 28, p. 27, 1914; T. S. Oldroyd, p. 82, 1914; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 281, 1927.

Amphissa (*? versicolor* Dall, var.) *lineata* Stearns, Proc. Calif. Acad. Sci., Vol. 4, p. 322, pl. 1, fig. 8, 1872.

Amphissa versicolor lineata Stearns, Dall, Nautilus, Vol. 30, p. 27, 1916; Bull. 112, U. S. Nat. Mus., p. 105, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925.

Type specimen: In the U. S. National Museum.

Type locality: Monterey, California.

Pleistocene: Lower San Pedro series at Deadman Island, Los Angeles County; upper San Pedro series at Deadman Island, Los Cerritos (Signal Hill), and Crawfish George's, Los Angeles County; Pleistocene of Pacific Beach, San Diego County (Arnold, 1903); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan, 1926); lower San Pedro fauna of Nob Hill cut, San Pedro (as *lineata*, T. S. Oldroyd, 1924).

Recent: Oregon to Cedros Island, Lower California, Mexico.

This species is smaller than *A. columbiana*, the average length being about 10 or 12 mm., while *columbiana* averages over 20 mm. It has a number of named varieties. The metropolis of the typical form is at or near Monterey, California.

Variety *lineata* Stearns was poorly figured by its author and not described. It may purport to be a more strongly spirally sculptured form, but it is best considered a synonym. Mr. Oldroyd's fossil specimens are not varietally different.

Genus COSMIOCONCHA Dall, 1913

Cosmioconcha Dall, Proc. U. S. Nat. Mus., Vol. 45, p. 589, 1913, type, *Buccinum modestum* Powys.[2]

This group differs from *Amphissa* by the almost or complete absence of axial sculpture. *C. pergracilis* (Dall),[3] is a slender, high-spired species in the Recent Lower California fauna. *C. palmeri* (Dall), *C. parvula* (Dall), *C. modesta* (Powys), *C. brunneocincta* Dall, and *C. buccinoides* (Sowerby) complete the list of Recent Cosmioconchas.[4] None of these species has been reported fossil up to this time. The genus takes the place of *Amphissa* in the tropical fauna.

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[1] Proc. U. S. Nat. Mus., Vol. 15, p. 213, pl. 20, fig. 4, 1892, article by Williamson.

[2] Proc. Zool. Soc. London for 1835, p. 94, 1835, figured by Reeve, Conch. Icon., *Buccinum*, pl. 4, sp. 19, 1846; Pacific coast Central America. Recent.

[3] Dall, Proc. U. S. Nat. Mus., Vol. 45, p. 590, 1913, figured in U. S. Nat. Mus., Vol. 66, Art. 17, pl. 21, fig. 8, 1925.

[4] In this case, as in others, we are indebted to Mr. A. M. Strong of Los Angeles for data on the Recent fauna of the region south of San Diego, California.

Genus AESOPUS Gould, 1860

Aesopus Gould, Proc. Boston Soc. Nat. Hist., Vol. 7, p. 383, December, 1860.

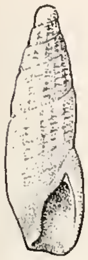
Type (by monotypy), *Aesopus japonicus* Gould, Proc. Bost. Soc. Nat. Hist., Vol. 7, p. 383, 1860, no figure.

Shell small, rather thick for its size, subcylindric, terminating in a blunt apex; body whorl scarcely larger than the penultimate whorl; whorls slightly convex; sutures not deeply impressed; surface shiny, vitreous; sculpture inconspicuous or microscopic, consisting of very low axial ribs and spiral striations, absent in some places; aperture small, one-third or less the length of the shell, elongate-ovate, tending to be effuse below and narrowing above; outer lip typically simple but occasionally with denticulations within; inner lip a vitreous callus deposit; columella short; anterior canal not differentiated from the anterior part of the aperture; posterior canal undeveloped.

Geologic range: Pleistocene to Recent.

Distribution: Warm and temperate waters.

Species belonging to this well-characterized genus are readily recognized by their subcylindric shape, with the body whorl hardly larger than the two preceding whorls, the small aperture, and the blunt apex. The earliest fossil occurrence yet recorded is Pleistocene, but the apparent absence of species of this genus in the Pliocene may be due to their susceptibility to destructive agencies.


Text figure 8. *Æsopus japonicus* Gould, Recent specimen in the Oldroyd Collection at Stanford University; magnification, × 6.

A. japonicus, the type of the genus, has a smooth, shining nuclear whorl, but the following whorls show both axial and spiral sculpture under moderate magnification. The axial ribs are nearly uniform in strength from suture to suture and begin abruptly after the nuclear whorl. The spiral striations are very fine, widely and unequally spaced, and easily removed by abrasion. The aperture of *japonicus* is narrower and more elongate than the apertures of *A. chrysalloideus*, *hemphilli*, and *myrmacoon* and does not bear teeth or lirations on the outer lip.

Aesopus chrysalloideus (Carpenter)

Amycla chrysalloidea Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 613, 1864, reprinted in Smithsonian Misc. Coll. No. 252, p. 99, 1872.

? *Amycla chrysalloidea* Carpenter, Proc. Calif. Acad. Sci., Vol. 3, p. 223, Feb., 1866.

Columbella chrysalloidea Carpenter, Tryon, Man. Conch., Ser. 1, Vol. 5, p. 135, pl. 50, fig. 42, 1883.

Astyris chrysalloidea Carpenter, Keep, West Coast Shells, p. 36, 1888, 1892.

Columbella (*Aesopus*) *chrysalloidea* Carpenter, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 213, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 237, pl. 5, fig. 6, 1903.

Aesopus chrysolloideus Carpenter, Kelsey, Nautilus, Vol. 13, no. 9, p. 103, 1900.

Aesopus chrysalloides, Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 105, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 1, p. 279, 1927.

Type specimen: In the State Collection, No. 613, at the University of California.

Type locality: San Pedro, California, Recent.

Pleistocene: Lower San Pedro fauna of Deadman Island and San Pedro, "rare" (Arnold); upper San Pedro fauna at San Pedro, "not uncommon" (Arnold); Pleistocene of 26th Street, San Diego (Arnold).
Recent: San Pedro to San Diego, California.

This species is characterized by its comparatively large size, rather even, fine spiral sculpture, and chrysalis shape. The suture on the body whorl seems to descend on the penultimate whorl, giving the shell a rather lopsided or bent appearance, which, although a minor generic character, is accentuated in this species.

Aesopus idæ Bartsch

Aesopus idæ Bartsch, Proc. Biol. Soc. Wash., Vol. 31, p. 79, June, 1918; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Article 22, p. 12, 1925.

Type specimen: In the U. S. National Museum.

Type locality: San Pedro, California, Pleistocene.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd).

This large species is known only from the type specimen.

Columbella (*Aesopus*) *oldroydi* Arnold, described from the Pleistocene of San Pedro, was renamed *Mangilia cetolaca* Dall, as the change of generic assignment required a new specific name. Arnold had already used the combination *Mangilia oldroydi* for a new species of *Lora* described on an earlier page of the same paper.

Family MURICIDAE

Genus MUREX Linnæus, 1758

Murex Linnæus, Syst. Nat., Ed. 10, p. 746, 1758; Montfort, Conch. Syst., Vol. 2, p. 619, 1810; Tryon, Man. Conch., Ser. 1, Vol. 2, p. 73, 1880; Woodring, Carnegie Inst., Publ. No. 385, p. 287, 1928.

Aranea Perry, Arcana, pl. 47, December, 1810, type (by monotypy), *Aranea gracilis* Perry, pl. 47, December, 1810, + *Aranea triremis* Perry, Conchology, pl. 45, fig. 3, April, 1811, + *Murex tenuispina* Lamarck, 1822; Matthews and Iredale, Victorian Naturalist, Vol. 29, p. 12, 1912.

Type (by subsequent designation, Montfort, 1810), *Murex pecten* Montfort = *M. tribulus* Linnæus, figured by Tryon, Man. Conch., Ser. 1, Vol. 2, p. 77, pl. 9, figs. 107, 109, 1880; Indo-Pacific, Recent.

Shell with produced spire; very long, slender anterior canal nearly closed except near the base; whorls usually with three prominent, sometimes spiny varices.

Purpura differs in that the varices are frill-like and the anterior canal is shorter.

Subgenus **MUREX**, s. s.

Varices with long spines.

It is possible that some fossil species of typical *Murex* would be so mutilated that their subgeneric affiliation would be obscured. The presence or absence of a tooth-like projection on the anterior part of the outer lip probably will be found not entirely reliable for systematic purposes.

Subgenus **BRONTES** Montfort, 1810

Brontes Montfort, Conch. Syst., Vol. 2, p. 622, text figure, 1810.
"*Murex* Linnæus," Lamarck, Syst. Anim. s. Vert., p. 81, 1801; also typical *Murex* of several later authors.

Type (by original designation), *Murex haustellum* Linnæus, also figured by Tryon, Man. Conch., Ser. 1, Vol. 2, p. 83, pl. 13, fig. 137, 1880; Indo-Pacific, Recent.

Shell like that of *Murex, s. s.*, but without the long spines on the varices.

This subgenus is not represented in the late Tertiary nor the Quaternary faunas of California. *Murex nigrescens* Sowerby[1] of the west Colombian Recent fauna is a member of this subgenus.

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[1] Proc. Zool. Soc. London, Pt. 8, p. 138, July, 1841; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 23, fig. 92, 1845.

Genus **PURPURA** Martyn, 1784

Purpura Martini, Neues Syst. Conch. Cab., Vol. 3, p. 293, 1777, not consistently binomial.

Purpura Martyn, Univ. Conch., Vol. 2, pl. 66, explanatory table, 1784; Dall, Proc. Biol. Soc. Wash., Vol. 18, p. 189, 1905.

Type (by monotypy), *Purpura foliata* Martyn, figured by Tryon, Man. Conch., Vol. 2, p. 113, pl. 34, figs. 370, 371, 1880.

Shell with prominent varices, usually three to each whorl, often frill-like; anterior canal short, tightly closed; with or without a tooth-like projection on the anterior portion of the outer lip.

Subgenus **PURPURA**, s. s.

Shell with three frill-like varices to each whorl; tooth-like process on the anterior portion of the outer lip.

Purpura (Purpura) foliata Martyn

Purpura foliata Martyn, Univ. Conch., Vol. 2, pl. 66, and explanatory table, 1784; Dall, U. S. Nat. Mus., Bull. 112, p. 106, 1921; Amer. Journ. Sci., Ser. 5, Vol. 4, p. 314, 1922; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 14, 1927.

Murex foliatus Gmelin, Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 3, fig. 12, 1845.

Murex foliatus Martyn, Sowerby, Thes. Conch., Vol. 4, *Murex*, p. 24, pl. 11, fig. 110, 1880.

Murex (Cerostoma) foliatus Martyn, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 113, pl. 34, figs. 370, 371, 1880.

Murex (Pterorhytis) foliatus Martyn, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 245, 1903.

Purpura perponderosa Dall, U. S. Geol. Surv., Prof. Paper 59, p. 46, pl. 2, figs. 2, 5, April 2, 1909; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93 and table opposite, 1922.

? *Aporrhais (Arrhoges) quillayutensis* Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 226, pl. 6, fig. 65, 1909.

Type locality: Sitka, Alaska, Recent.

Miocene: Empire formation of Coos Bay, Oregon (Dall, 1909, as *perponderasa*); Quillayute formation of Washington (Reagan), in supposedly Pliocene beds, probably reworked upper Miocene sandstone.
Pleistocene: Rare in upper San Pedro series of San Pedro (Arnold).
Recent: Sitka, Alaska, to San Diego, California (Dall, 1921).

Purpura (Purpura) nuttalli (Conrad)

Murex (Cerostoma) nuttalli Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 264, pl. 20, fig. 22, 1837.

Murex nuttalli Conrad, Sowerby, Thes. Conch., Vol. 4, *Murex*, p. 27, pl. 11, figs. 102, 103, 104, 1888.

Cerostoma nuttalli Conrad, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 233, 1888.

Murex (Pterorhytis) nuttalli Conrad, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 245, 1903.

Purpura nuttallii albescens Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 332, 1919; U. S. Nat. Mus., Bull. 112, p. 107, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 15, 1927.

Purpura nuttallii albofasciata Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 332, 1919; U. S. Nat. Mus., Bull. 112, p. 107, 1921; I. S. Oldroyd, *op. cit.*, p. 15, 1927.

Purpura nuttallii Dall, U. S. Nat. Mus., Bull. 112, p. 107, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, *op. cit.*, p. 14, 1927.

Type specimen: At the Academy of Natural Sciences of Philadelphia.

Type locality: Santa Barbara, California, Recent.

Pleistocene: "Rare in upper San Pedro series at Deadman Island and Los Cerritos" (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California, to Magdalena Bay, Lower California, Mexico.

This species has a rather prominent bulge or nodosity on the upper part of the whorl between each varix. The outer lip has a prominent tooth near the base, and within there are several small teeth, often five or six. The outer margin of the last two varices on adult specimens flares backward somewhat but is not frilled as in *foliata*. The spiral cords are fewer and much less pronounced than in *foliata*.

Purpura (Purpura) nanna Nomland

Purpura nana Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 310, pl. 19, figs. 1*a*, 1*b*, November 8, 1917.

Type specimen: In the University of California collection.

Type locality: North of Coalinga, California; Miocene.

Miocene: Santa Margarita formation, upper Miocene, north of Coalinga (Nomland).

This form is similar to *Purpura foliata* Martyn.

Purpura (? Purpura) trialata (Sowerby)

Murex trialatus Sowerby, Proc. Zool. Soc. London for 1840, p. 143, July, 1841; not *Murex trialatus* Kiener, 1843.

? *Murex californicus* Hinds, Proc. Zool. Soc. London, Pt. 11, p. 128, March, 1844; Zool. Voy. Sulphur, Moll., pl. 3, figs. 9, 10, 1844.

? *Muricidea californica* Hinds, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 69, 1868–9.

Murex trialatus Sowerby, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 113, pl. 34, figs. 372, ? 375, pl. 35, fig. ? 387, 1880.

Murex (Chicoreus ?) trialatus Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 343, 1903.

Alipurpura trialata Sowerby, Dall, U. S. Nat. Mus., Bull. 112, p. 106, 1921.

Murex (Alipurpura) trialatus Sowerby, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 10, 1927.

Pleistocene: Rare in upper San Pedro series at San Pedro, Deadman Island, and Crawfish George's, Los Angeles County (Arnold).

Recent: Bodega Bay, California, to Todos Santos Bay, Lower California, Mexico (Dall, 1921).

It is possible that *Purpura californica* (Hinds) is conspecific with *erinaceoides* (Valenciennes) instead of with *trialata*.

Purpura (? Purpura) monoceros (Sowerby)

Murex monoceros Sowerby, Proc. Zool. Soc. London for 1840, p. 143, July, 1841; Conch. Illust., *Murex*, p. 5, figs. 64, 65, 1841; Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 7, *Murex*, p. 83, pl. 17, fig. 2, 1843; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 2, fig. 7, 1845; Sowerby, Thes. Conch., Vol. 4, *Murex*, p. 28, pl. 10, fig. 86, 1880; not *Murex monoceros* d'Orbigny, Voy. Amér. Mérid., Moll., p. 454, pl. 78, figs. 1, 2, 1842 (?).

Muricidea (? Phyllonotus) paucivaricata Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 43, 69, pl. 14, fig. 1, 1868-9.

Murex (Cerostoma) monoceros Sowerby, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 115, pl. 35, figs. 388, 389, 1880.

Muricidea paucivaricata Gabb, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 252, 1888.

Murex (Pterorhytis) monoceros Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 246, 1903.

Purpura monoceros Sowerby, Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 388, pl. 32, fig. 1, 1927.

Type specimen: Of *paucivaricata* Gabb, in the collection at the University of California.

Type locality: Of *monoceros*, Lower California, Mexico, Recent; of *paucivaricata*, San Diego, Pleistocene ?

Pleistocene: Santa Barbara; San Diego (Cooper); San Pedro (Gabb); "Rare in upper San Pedro series of San Pedro" (Arnold).

Recent: Lower California, Mexico.

This species has subdued varices and may not belong to typical *Purpura*. The amount of individual or specific variation in the strength of the varices is not known.

Subgenus **CENTRIFUGA**, new subgenus

Type, Murex centrifuga Hinds, Proc. Zool. Soc. London, Pt. 11, p. 126, March, 1844; Zool. Voy. Sulphur, Moll., pl. 3, figs. 7, 8, 1844; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 28, fig. 130, 1845; west coast of Veragua, Panama.

Shell like that of the typical subgenus but with three long, rather stout, round-tipped spines on each whorl instead of the three frill-like varices; anterior canal moderately long, tightly closed.

Dall, in describing *leeana*, stated that he knew of no other species except *centrifuga* belonging to this peculiar group. So far as the writers could ascertain, no name has been proposed hitherto for either of the species. The relation to the other groups of *Purpura* seems clear; but on the other hand, the distinctions between this group and the others are as great as those between the *festiva* group and typical *Purpura*. Alternating with the long spines are low, dome-like nodes, making the projections per whorl six in all, corresponding to the rounded varices of species like *gemma*. The general appearance of *Forreria* (*Austrotrophon*) *catalinensis* (Oldroyd) is similar, but a closer examination of the latter shows that the spine-like projections are formed very differently by the detachment of thin lamellæ, producing hollow projections. The spines of *Centrifuga* are solid except for a small groove on the anterior side. On the other hand, the relation between *catalinensis* and *belcheri* is genetically very close.

P. centrifuga is like *leeana* but smaller and with a few spiral ridges on the lower part of the body whorl, which are reflected as small scallops on the lower part of the terminal, varix-like thickening of the outer lip. The two may be found to intergrade.

The only name that the writers could find that applies to species at all similar is *Poirieria* Jousseaume.[1] Although probably allied to *Centrifuga*, it does not appear to be closely allied, for the type is a very thin-shelled, more spiney species, with five or more instead of three varices. Another species somewhat similar to *centrifuga* is *tenuicornis* (Tate) from the "clayey green sands, Adelaide bore," older Tertiary of South Australia.[2] It may be that all of these species are allied sufficiently closely so that *Centrifuga* should be considered only a section of *Poirieria*.

Purpura (Centrifuga) leeana (Dall)

Murex (*Chicoreus*) *leeanus* Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 329, pl. 7, fig. 1, 1889; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 243, pl. 7, fig. 1, 1903.

Type specimen: In the U. S. National Museum.

Type locality: Off Cedros Island, Lower California, Mexico, in 44 fathoms, mud.

Pleistocene: Upper San Pedro series at San Pedro and Crawfish George's, Los Angeles County, "rare" (Arnold).

Recent: Guadalupe Island to Cedros Island, Lower California, Mexico.

Subgenus **JATON** Pusch, 1837

Jaton Pusch, Polens Paleont., pt. 2, p. 135, 1837; Sherborn, Index Anim., Sect. 2, p. 3280, 1928.

Jatova Jousseaume, Rev. de Zool., 1879 ?; Le Naturaliste, An. 2, p. 335, Dec. 15, 1880, type (by original designation) *Purpura jatova* Adanson.

Type (*fide* Sherborn), *Murex decussatus* Linnæus, Gmelin in Linnæus, Syst. Nat., Ed. 13, p. 3527, 1790 (= ? *Murex decussatus* Meuschen, Mus. Gever, p. 332, 1787), + *Le Jatou* Adanson, Hist. Nat. du Sénégal, p. 129, pl. 9, fig. 21, 1757; + *Murex gibbosus* Lamarck, Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 9, p. 580, 1843; *Murex lingua-vervecina* Chemnitz, Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 27, fig. 121, Aug., 1845; Recent, Senegal, west coast of Africa.

Shell like that of the typical subgenus but with the three lamellar projections much reduced, either entirely absent or merely low shields next to the low, rounded varices, another set of varices without the lamellar shields alternating with the originals and practically as strong.

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[1] Le Naturaliste, An. 2, p. 335, Dec. 15, 1880; type (by original designation), *Murex zealandicus* Quoy and Gaimard, Zool. Voyage de l'Astrolabe, Vol. 3, p. 529, pl. 36, figs. 5-7, 1833; Reeve, Conch. Icon., *Murex*, pl. 34, species 177, October, 1845; Cook's Straits, New Zealand.

[2] *Murex* (*Chicoreus*) *tenuicornis* Tate, Trans. Roy. Soc. So. Australia, Vol. 10, p. 100, pl. 2, fig. 6, 1888.

This subgenus has been called *Triremis*[1] by Dall and others. However, the type of *Triremis* has much stronger lamellar frills than the species listed here, the name is an exact synonym of *Purpurellus*,[2] having the same type, and *Jaton* is not only much older but applies more exactly to this group.

Purpura (Jaton) festiva (Hinds)

Plate 32, Figure 3

Murex festivus Hinds, Proc. Zool. Soc. London, Pt. 11, p. 127, March, 1844; Zool. Voy. Sulphur, Moll., p. 9, pl. 3, figs. 13, 14, 1844; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 26, fig. 14, 1845; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Murex (*Cerostoma*) *festivus* Hinds, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 116, pl. 35, fig. 383, 1880.

Pteronotus festivus Hinds, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 70, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 261, 1888.

Murex (*Pteronotus*) *festivus* Hinds, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 244, 1903.

Murex (*Triremis*) *festivus* Hinds, Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 13, 1927.

Triremis festiva Hinds, Dall, U. S. Nat. Mus., Bull. 112, p. 106, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Murex (*Triremis*) *festiva* Hinds, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: Magdalena Bay, Lower California, Mexico, Recent.

Pliocene: Rare in the *Pecten coalingensis* zone, middle Etchegoin formation of the Coalinga region (Nomland).

Pleistocene: "Saugus" formation near Ventura (Waterfall); lower San Pedro series at Deadman Island, rare; upper San Pedro at Deadman Island, Crawfish George's, San Pedro, and Los Cerritos, Los Angeles County; Spanish Bight, San Diego (Arnold); Santa Monica (in Oldroyd Collection at Stanford University); lower Quaternary at Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926).

Recent: Santa Barbara, California, to San Ignacio Lagoon, Lower California, Mexico (Jordan, 1924).

Purpura (Jaton) eldridgei (Arnold)

Plate 32, Figures 1, 2*a*, 2*b*

Murex eldridgei Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 537, pl. 50, fig. 12, 1907; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, pl. 40, fig. 12, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 212, 1914.

Type specimen: In the U. S. National Museum, No. 164,955.

Type locality: Elsmere Canyon, near Union Oil Company's wells, 2½ miles southeast of Newhall, Los Angeles County, lower Pliocene.

Pliocene: Lower Pliocene of Elsmere Canyon (Arnold); lower Pliocene at S. D. S. N. H. locality 203, Elsmere Canyon, and locality 216, east of Fernando Pass, all Los Angeles County (H. R. G.).

This species seems to be related to *Purpura* (*Jaton*) *gemma* (Broderip). It may even be a variety of it.

Genus TRITONALIA Fleming, 1828

Tritonalia Fleming, Hist. Brit. Anim., errata on last page changing the name of *Triton* on pp. 346, 356, 1826; Iredale, Journ. Conch., Vol. 14, p. 345, 1915.

"*Ocenebra* Leach MSS. 1818," Gray, Proc. Zool. Soc. London for 1847, p. 133, 1847.

Type (by subsequent designation, Gray, 1847), *Murex erinaceus* Linnæus, figured by Tryon, Man. Conch., Ser. 1, Vol. 2, p. 116, pl. 36, figs. 401, 402, 403, 1880; European coast, Recent.

Shell generally small, purpuriform, with many varices, which may be foliated or spinose; spiral sculpture generally present; anterior canal partly or nearly closed.

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[1] *Triremis* Bayle in Fischer, Man. de Conchyl., p. 641, June 30, 1884, type (by monotypy), *Murex gambiensis* Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 16, species 65, June, 1845, from the mouth of the Gambia, west coast of Africa.

[2] *Purpurellus* Jousseaume, Le Naturaliste, An. 2, p. 335, Dec. 15, 1880, type (by original designation), *Murex gambiensis* Reeve.

The type of *Tritonalia* is a more ornate species than most of the west American forms assigned to the genus. However, it is a very variable species (because it comes from Europe and is well known), and some specimens show clearly its relationship with the west American forms. If more exact sectional names are desired, *Ocinibrina* Jousseaume[1] and probably others are available. *Pterorytis* Conrad,[2] originally spelled without an "h," is distinguished by its six (or more) lamellar varices. Although it is clearly related to *Jaton*, it may be closer to *Tritonalia*. Perhaps it could be used for such species as *keepi*, of which Nomland's *turris* may be a variety.

A careful study of the Pacific coast representatives of this genus will probably result in a reduction in the number of named forms. The following is a mere alphabetical list of the known and named Pliocene and Pleistocene species and varieties.

Tritonalia barbarensis (Gabb)

Murex barbarensis Gabb, Proc. Calif. Acad. Sci., Vol. 3, p. 183, 1865; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919.

Muricidea barbarensis Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 69, 1868-9.

Ocinebra barbarensis Gabb, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 254, pl. 5, fig. 1, 1903.

Tritonalia barbarensis Gabb, U. S. Nat. Mus., Bull. 112, p. 108, pl. 6, fig. 5, pl. 15, fig. 11, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 25, pl. 30, fig. 5, 1927.

Type specimen: In the collection at the University of California ?

Type locality: Catalina Island, California, in 40 fathoms.

Pliocene: Santa Barbara (Arnold, as Pleistocene).

Pleistocene: Lower San Pedro series at San Pedro and Deadman Island, "rare" (Arnold); at the chiton bed on Point Firmin, Los Angeles County (Chace).

Recent: British Columbia to the Channel Islands off southern California.

This is a rather high-spired species with blunt spines at the margin of the tabulation on the whorls. The anterior canal is partly closed.

Tritonalia foveolata (Hinds)

Plate 32, Figure 11

Murex foveolatus Hinds, Proc. Zool. Soc. London, Pt. 11, p. 127, March, 1844; Sowerby, Thes. Conch., Vol. 4, *Murex*, p. 47, pl. 24, fig. 253, 1880.

Murex (Ocinebra) foveolatus Hinds, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 125, pl. 38, fig. 466, 1880.

Muricidea foveolata Hinds, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 252, 1888.

Tritonalia foveolota Hinds, Dall, U. S. Nat. Mus., Bull. 112, p. 108, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 22, 1927.

Type locality: Magdalena Bay, Lower California, Mexico, Recent.

Pleistocene: Santa Barbara (Cooper, possibly Pliocene ?); upper San Pedro series of San Pedro, "one imperfect specimen found" (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan); Las Posas zone in Adams Canyon, Ventura Co. (U. S. G.).

Recent: Monterey to San Diego, California (Dall).

The specimen figured is a variant with less prominent axial ribs and possibly a heavier shell than the average of Recent specimens, but the species is quite variable.

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[1] *Ocinibrina* Jousseaume, Le Naturaliste, An. 2, p. 335, Dec. 15, 1880, type (by original designation), *Fusus coralinus* Scacchi, figured by Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 32, species 164, August, 1845, as *Murex inconspicuus* Sowerby; English Channel.

[2] *Pterorytis* Conrad, Proc. Acad. Nat. Sci. Phila., Vol. 14 (for 1862), p. 560, *ante* Feb. 26, 1863; type (by monotypy), *Murex umbifer* Conrad, Foss. Shells Tert. Form., Vol. 1, no. 1, p. 17, pl. 3, fig. 2, October, 1832; Emmons, Rept. Geol. N. Carolina, p. 247, fig. 104*a*, 1858 (+ *sexcostata* Emmons, p. 248, fig. 106, *fide* Conrad, 1863); Conrad, Amer. Journ. Conch., Vol. 4, p. 64, pl. 5, fig. 7, 1868; Tryon, Struct. and Syst. Conch., Vol. 2, p. 106, pl. 43, fig. 11, 1883; Miocene of James River, Yorktown, etc., Virginia, and of North Carolina. *M. umbifer* is very much like specimens of *Murex euripteron* Reeve from Japan in the collection at the California Institute of Technology. In Reeve's figure of this species (Conch. Icon., Vol. 3, *Murex*, pl. 34, species 176, October, 1845) the varices are extreme. Hence *Ocinebrelius* Jousseaume, 1880, of which *euripteron* is the type, is a synonym. *Cerostoma* Conrad, 1837, not Latreille, 1802, is probably another synonym.

Tritonalia interfossa (Carpenter)

Ocinebra interfossa Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 663, 1864; Proc. Acad. Nat. Sci. Phila. for 1864, p. 64; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 70, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 254, 1880; Keep, West Coast Shells, p. 24, fig. 5, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 255, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908.

Murex (Ocinebra) interfossus Carpenter, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 131, pl. 39, fig. 484, 1880.

"*Boreotrophon stuarti* Smith," Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913, *fide* Howe, 1922, not of Smith.

Tritonalia interfossa Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 108, pl. 11, fig. 8, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 21, pl. 30, fig. 2, 1927.

Murex (Ocinebra) interfossa Carpenter, Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93 and table opposite, 1922.

? Miocene: Empire formation of Coos Bay, Oregon (Arnold and Hannibal, as *Boreotrophon stuarti* Smith, according to Howe, 1922).

Pliocene: Coos conglomerate, Coos Bay, Oregon (Howe); Bath-house Beach, Santa Barbara (Berry).

Pleistocene: "Pliocene" of Deadman Island, one specimen; lower San Pedro series at Deadman Island and San Pedro and upper San Pedro series at Crawfish George's and Deadman Island, Los Angeles County; also Pleistocene at Pacific Beach, San Diego (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Semidi Islands, Alaska, to San Diego, California (Dall).

This species is characterized by the lattice-like or coarse, widely reticulate sculpture.

Tritonalia interfossa (Carpenter) variety **beta** Dall

Tritonalia interfossa beta Dall, Proc. Biol. Soc. Washington, Vol. 32, p. 250, 1919.

"*Tritonalia interfossa beta* (Carpenter), Dall," U. S. Nat. Mus., Bull. 112, p. 108, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 22, 1927.

"*Tritonalia interfossa,* var. *beta* Carpenter," T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925.

Type specimen: In the U. S. National Museum, No. 46,728.

Type locality: Monterey, California, Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, "plentiful" (T. S. Oldroyd).

Dall stated that this shell resembles *T. barbarensis* (Gabb), but is stouter and lacks the recurved spines at the shoulders.

Tritonalia keepi (Arnold)

Ocinebra keepi Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 256, pl. 5, fig. 9, 1903.

Tritonalia keepi Arnold, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925.

Type specimen: In the U. S. National Museum, No. 162,543.

Type locality: Deadman Island, Los Angeles; Pleistocene.

Pleistocene: Lower San Pedro fauna of Nob Hill cut (Oldroyd); upper San Pedro at Deadman Island, at the lumber yard and at San Pedro, Los Angeles County, "rare" (Arnold).

Tritonalia keepi (Arnold) variety **turris** (Nomland)

Purpura turris Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 86, pl. 7, fig. 4, 1916; Vol. 10, p. 252, pl. 11, figs. 4*a*, 4*b*, 1917.

Type specimen: In the collection at the University of California.

Type locality: West of Coalinga, Pliocene.

Pliocene: Lower and upper Etchegoin formation, west of Coalinga (Nomland).

The relationships of this species have not been investigated, except to note its resemblance to *Tritonalia keepi.*

Tritonalia lurida (Middendorff)

Tritonium (Fusus) luridum Middendorff, Bull. Phys. Math. Ac. Imp. Sci. St. Petersburg, Vol. 7, p. 244, November, 1848.

Tritonium luridum Middendorff, Beiträge zu Einer Malacozoologia Rossica, Vol. 1, Pt. 2, p. 150, pl. 4, figs. 4, 5, 1849.

Murex (Ocinebra) luridus Middendorff, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 131, pl. 39, figs. 481, 485, 1880.

Ocinebra lurida Middendorff, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 215, pl. 20, fig. 3, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 256, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908 (as variety tending toward variety *munda*).

Tritonalia lurida Middendorff, Dall, U. S. Nat. Mus., Bull. 112, p. 107, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 12, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 106, 1927.

Type specimen: In the collection at the St. Petersburg Academy.

Type locality: Sitka, Alaska, Recent.

Pliocene: Bath-house Beach upper Pliocene, Santa Barbara (Berry).

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); "rare in upper San Pedro series of San Pedro; one deformed specimen from Crawfish George's," Los Angeles County; Pacific Beach, late Pleistocene, San Diego County (Arnold).

Recent: Forrester Island, Alaska, to Catalina Island, California (Dall, 1921); ? San Pedro.

Tritonalia lurida (Middendorff) variety **aspera** (Baird)

Plate 32, Figure 4

Vitularia aspera Baird, Proc. Zool. Soc. London for 1863, p. 66.

Ocinebra lurida var. *aspera* Baird, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 663, 1864.

Ocinebra lurida Midd., var. *aspera* Baird, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 257, pl. 5, fig. 12, 1903.

Tritonalia lurida aspera Baird, Dall, U. S. Nat. Mus., Bull. 112, p. 107, pl. 13, fig. 12, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 17, pl. 32, fig. 1, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: In the British Museum (Natural History).

Type locality: Esquimalt Harbor, Vancouver Island, British Columbia, Recent.

Pliocene: Uppermost Pliocene at Bath-house Beach, Santa Barbara (Arnold).

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro (Arnold); "Saugus" near Ventura (Waterfall); irrigation ditch near Ventura; also in upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island (Arnold); S. D. S. N. H. locality 74, late Pleistocene southwest of Goleta, Santa Barbara County (U. S. G.).

Recent: Sitka, Alaska, to San Pedro, California (Dall, 1921).

? **Tritonalia lurida** (Middendorff) variety **cancellina** (Philippi)

Fusus cancellinus Philippi, Arch. f. Naturg., Vol. 11, Pt. 1, p. 67, 1845; Abbild. Beschr. Conchyl., Vol. 2, Heft 4, p. 117, *Fusus*, pl. 3, fig. 2, August, 1846.

Urosalpinx cancellina Philippi, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 154, pl. 39, fig. 492, 1880.

Ocinebra lurida Midd., var. *cancellina* Philippi, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 257, pl. 9, fig. 11, 1903.

Pleistocene: "Rare in the upper San Pedro series at San Pedro" (Arnold).

Recent: Straits of Magellan (Philippi; Tryon).

Arnold's figure shows a slightly lower spired shell with fewer axial ribs than that pictured by Philippi.

Tritonalia lurida (Middendorff) variety **cerritensis** (Arnold)

Ocinebra lurida Midd., var. *cerritensis* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 258, pl. 5, fig. 5, 1903

Type specimen: In the U. S. National Museum, No. 162,544.

Type locality: Crawfish George's, near San Pedro, Los Angeles County, Pleistocene.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro; rare in the upper San Pedro series of the San Pedro region (Arnold).

Arnold stated that this variety was distinguishable from others by the "large body-whorl, depressed appearance, small size and heavy shell."

Tritonalia lurida (Middendorff) variety **munda** (Carpenter)

Plate 32, Figure 5

Ocinebra var. *munda* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 663, 1864.
Ocinebra lurida var. *munda* Carpenter, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 215, pl. 20, fig. 3, 1892.
Ocinebra lurida Midd., var. *munda* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 258, 1903.
? Turris kirkensis Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 504, pl. 69, figs. 5, 6, 7, 1915, young shell.
Mangilia muricidea Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 55, pl. 1, figs. 10*a*, 10*b*, 1916.
Tritonalia lurida munda Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 107, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 18, 1927.

? Miocene: From region of Kirker's Pass to north of Mount Diablo, in the lower division of the San Pablo group, upper Miocene (Clark, as *Turris kirkensis*).
Pliocene: Fourth and Broadway, Los Angeles, lower part of upper Pliocene (Moody, as *Mangilia muricidea*).
Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles County (Arnold); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan); late Pleistocene southwest of Goleta, Santa Barbara County (U. S. G.).
Recent: Middleton Island, Alaska, to San Diego, California (Dall, 1921).

Tritonalia perita (Hinds)

Murex peritus Hinds, Proc. Zool. Soc. London for 1843, p. 129; Zool. Voy. Sulphur, Moll., p. 9, pl. 3, figs. 23, 24, 1844; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 29, fig. 139, 1845.
Murex (*Ocinebra*) *peritus* Hinds, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 124, pl. 37, fig. 438, 1880, as synonym of *M. lugubris* Broderip.
Muricidea perita Hinds, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 252, 1888.
Ocinebra perita Hinds, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 259, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908.

Pliocene: Bath-house Beach, Santa Barbara, California (Arnold; Berry).
Pleistocene: Lower San Pedro series at Deadman Island; upper San Pedro series of Deadman Island, San Pedro, and Crawfish George's; Pacific Beach, San Diego (Arnold).
Recent: West coast of Mexico.

The fossil records of Cooper, Arnold, and Berry may refer to some other species.

Tritonalia poulsoni (Nuttall in Carpenter)

Plate 32, Figure 10

Ocinebra paulsoni (Nutt. MS.) Carpenter, Journ. de Conchyl., Vol. 12, p. 148, April, 1865; Cooper, Calif. St. Mining Bureau, Bull. 4, Pt. 3, p. 30, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 260, pl. 5, fig. 2, 1903.
Murex (*Ocinebra*) *paulsoni* Nuttall, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 130, pl. 38, fig. 475, 1880.
? Raperia raperi Dall, in part, see *Kelletia kelletii.*
Tritonalia poulsoni Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 107, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 19, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: San Diego, California, Recent.

Pleistocene: "Saugus" formation near Ventura (Waterfall); lower San Pedro series at Deadman Island and San Pedro, "rare"; upper San Pedro series at San Pedro, Los Cerritos, Crawfish George's, and Deadman Island, Los Angeles County, and at the foot of Twenty-sixth Street, San Diego (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Barbara, California, to Magdalena Bay, Lower California, Mexico (Dall).

Tritonalia subangulata (Stearns)

Murieidea subangulata Stearns, Conch. Memo., No. 12, p. 5, pl. 1, fig. 4, 1873; Proc. Calif. Acad. Sci., Vol. 5, p. 81, pl. 1, fig. 4, 1873.

Murex (Ocinebra) subangulatus Stearns, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 125, pl. 38, fig. 466, 1880.

Ocinebra michæli Ford, Proc. Acad. Nat. Sci. Phila. for 1888, p. 186; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 259, pl. 5, fig. 15, 1903.

Tritonalia subangulata Stearns, Dall, U. S. Nat. Mus., Bull. 112, p. 108, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 24, 1927.

Type locality: San Miguel Island, California, Recent.

Pleistocene: Upper San Pedro series at Crawfish George's, near San Pedro, Los Angeles County, "one specimen" (Arnold).

Recent: Monterey to Santa Barbara Islands, California (Dall).

Tritonalia subangulata (Stearns) variety **waldorfensis** (Arnold)

Ocinebra micheli Ford, var. *waldorfensis* Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 17, pl. 54, fig. 10, 1907.

Type specimen: In the U. S. National Museum, No. 165,261.

Type locality: Three miles southeast of Guadalupe, Santa Barbara County, Pliocene.

Pliocene: Waldorf asphalt mine, 3 miles southeast of Guadalupe, Santa Barbara County, California (Arnold).

"This slender little *Ocinebra* [=*Tritonalia*] differs from the typical *O. micheli* [=*T. subangulata*] in the following respects: it is slenderer, has less angular whorls, and the imbricated sculpture on the posterior portion of the whorl is less prominently developed; the axial ribs are more prominent posterior to the angle, the spiral lines are equal, not alternate, the aperture is narrower, and the canal more recurved." (Arnold.)

Tritonalia temelenta (Hanna)

Murex (Ocinebra) concinna Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 236, pl. 12, figs. 6, 6*a*, 1917; not *Murex concinnus* Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 25, fig. 105, 1845.

Murex temelentus Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 172, 1924, new name for *M. concinna* Nomland, not Reeve.

Type specimen: In the University of California collection, No. 11,093.

Type locality: In the *Chione elsmerensis* zone, lower Pliocene, near Coalinga, California.

Pliocene: Jacalitos formation, lower Pliocene, near Coalinga (Nomland).

This species may be a synonym of *Tritonalia tethys* (Nomland).

Tritonalia tethys (Nomland)

Murex (Ocinebra) tethys Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 221, 236, pl. 12, figs. 2, 2*a*, 2*b*, 1917.

? *Chrysodomus packardi* Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 221, 225, pl. 12, figs. 4, 4*a*, 4*b*, 1917, not *Chrysodomus packardi* Weaver, Univ. Washington Publ. Geol., Vol. 1, no. 1, p. 47, pl. 4, figs. 57, 58, 1916.

? *Chrysodomus ? prænominata* Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 162, 1924, new name for *C. packardi* Nomland, not Weaver.

Type specimen: In the University of California collection, No. 11,099.

Type locality: Zapato Creek, Fresno County, Pliocene.

Pliocene: Common in *Turritella nova* zone, rare in *Pecten coalingensis* zone, Etchegoin formation of Coalinga region (Nomland).

This form is somewhat like *Tritonalia circumtexta* (Stearns) except that it seems to have fewer spiral and coarser axial ribs. Judged by the few specimens we have examined, this species appears to have the variability characteristic of many species of *Tritonalia.* It includes probably *Tritonalia temelenta* (Hanna) as well as "*Chrysodomus*" *prænominata* Hanna. All these forms have a superficial resemblance to *Cancellaria,* but they lack the columellar plications of that genus.

Genus **EUPLEURA** H. and A. Adams, 1853

Eupleura H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 107, August, 1853; Fischer, Man. Conchyl., p. 643, 1884; Cossmann, Ess. Paléo. Comp., Vol. 5, p. 50, 1903.

Type (by subsequent designation, Cossmann, 1903), *Eupleura caudata* (Say), Journ. Acad. Nat. Sci. Phila., Vol. 2, p. 236, 1822, as *Ranella;* figured by Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 175, pl. 6, fig. 2, 1891, Atlantic coast of the United States from Cape Cod to Florida Keys, also fossil in North Carolina, Pliocene and possibly Miocene.

Shell with two opposite and continuous varices and smaller intermediate varices; aperture oval, anterior canal of moderate length, open.

Eupleura muriciformis (Broderip)

Ranella muriciformis Broderip. Proc. Comm. Sci. Zool. Soc. London, Pt. 2, p. 179, January, 1833; Reeve, Conch. Icon., Vol. 2, *Ranella,* pl. 7, fig. 34, 1844.

Ranella plicata Reeve, Proc. Zool. Soc. London for 1844, p. 138; Conch. Icon., Vol. 2, *Ranella,* pl. 7, fig. 33, 1844.

Ranella triquetra Reeve, Proc. Zool. Soc. London for 1844, p. 139; Conch. Icon., Vol. 2, *Ranella,* pl. 7, fig. 41, 1844; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 73, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 262, 1888.

Eupleura muriciformis Broderip, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 158, pl. 39, figs. 502, 504, 505, 1880; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 145, 1890; Proc. U. S. Nat. Mus., Vol. 14, p. 174, pl. 5, fig. 2, 1891; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 248, pl. 9, fig. 16, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 220, 1909; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924.

Pleistocene: "One specimen from lower San Pedro series at Deadman Island"; "rare in the upper San Pedro series of San Pedro"; foot of Twenty-sixth Street, San Diego (Arnold); upper Quaternary of San Ignacio Lagoon, Lower California, Mexico (Jordan).

Recent: Gulf of California, Mexico, to west Colombia (Dall, 1909).

The variety *unispinosa* Dall[1] may be an individual variant.

Eupleura muriciformis (Broderip) variety **curta** Arnold

Eupleura muriciformis Broderip, var. *curta* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 249, pl. 8, fig. 9, 1903.

Type specimen: In the U. S. National Museum, No. 162,559.

Type locality: San Pedro, Los Angeles County; upper Pleistocene.

Pleistocene: Upper San Pedro series at San Pedro, Los Angeles County (Arnold).

According to Arnold, this variety differs from typical *muriciformis* in "having obsolete varices, transverse ridges instead of nodes, much shorter canal, and in general much stronger sculpture."

? **Eupleura perangulata** (Nomland)

Murex perangulatus Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 206, pl. 11, figs. 1*a*, 1*b*, 1916.

Pliocene: Lower Pliocene of Fresno County (Nomland).

This species appears to have three prominent varices; and if it is a normal specimen, it may not belong to *Eupleura,* though Nomland's figure shows some characteristics of that genus.

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[1] Trans. Wagner Inst. Sci., Vol. 1, p. 146, 1890; Proc. U. S. Nat. Mus., Vol. 14, p. 174, pl. 6, fig. 5, 1891, type locality, Mazatlan, Mexico.

Genus THAIS Bolten, 1798

Thais Bolten, Mus. Boltenianum, p. 54, 1798; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 46-50, 1909; Iredale, Trans. Proc. New Zealand Inst., Vol. 47, p. 472, 1915; Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 557, 1915; Stewart, Proc. Acad. Nat. Sci., Phila., Vol. 78, p. 386, and footnote, 1927; Woodring, Carnegie Inst., Publ. No. 385, 1928.

Type (by subsequent designation, Iredale, 1915), *Thais neritoides* (Lamarck), = *Murex fucus* Gmelin, figured by Reeve, Conch. Icon., Vol. 3, *Purpura*, pl. 3, fig. 12, 1846; Cape Verde and Ascension Islands, Recent.

Shell stout, spire low, aperture large, columella flattened, anterior canal very short; sculpture predominantly spiral, modified into scales, nodes or even spines, axial sculpture absent or of lamellar irregularities.

The typical subgenus has not been reported from the later Cenozoic of California. It is characterized by a very large body whorl and aperture and an almost sunken spire. Although this subgenus looks very different from some species of *Nucella*, the group is very variable in characters and there are many intermediate species.

Subgenus STRAMONITA Schumacher, 1817

Stramonita Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 226, 1817, two species included, one of which is *Buccinum hæmastoma* Chemnitz, Neues Syst. Conch. Cab., Vol. 11, p. 80, pl. 187, figs. 1796, 1797, dated 1795, Martini, Vol. 3, p. 274, pl. 101, fig. 966, 1777, other figures of Martini cited by Chemnitz excluded; Cossmann, Ess. Paléo. Comp., Vol. 5, p. 71, 1903; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 386, Jan. 3, 1927; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 295, 1928.

Type (by subsequent designation, Cossmann, 1903), *Buccinum hæmastoma* Linnæus, Syst. Nat., Ed. 12, p. 1202, 1767, figured as *Purpura hæmastoma* Linnæus by Reeve, Conch. Icon., Vol. 3, *Purpura*, pl. 5, species 21, August, 1846; Mediterranean.

Shell like that of the typical subgenus but with higher spire, often with nodes or spines on the angle, a projection near the top of the inner lip, and a small posterior canal.

The two Neocene species, *ponderosa* and *imperialis*, are assigned to *Stramonita* questionably. They lack the projection near the top of the inner lip and their posterior canals are not defined. They may belong more properly in the *wilkesanus* group of *Chicoreus*.

Thais ? (Stramonita ?) imperialis (Dall)

Not *Purpura imperialis* Blainville, Nouv. Ann. Mus. Nat. Hist. (Paris), Vol. 1, pt. 2, p. 227, pl. 11, fig. 6, *post* May, 1832; Reeve, Conch. Icon., Vol. 3, *Purpura*, pl. 7, species 30, Aug., 1846.

Not *Murex* (*Phyllonotus*) *imperialis* Swainson, 1833.

Chrysodomus imperialis Dall, Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 353, 1908, manuscript name, *nomen nudum;* Dall, Prof. Paper 59 U. S. Geol. Surv., p. 42 (also pp. 17, 18), pl. 7, figs. 1, 3, ? pl. 18, fig. 1, 1909; Arnold, Bull. 396 U. S. Geol. Surv., p. 26, pl. 14, fig. 4, Jan. 15, 1910, figure reproduced in Bull. 398, pl. 36, fig. 4, 1910; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 594, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 422, pl. 68, fig. 2, 1915; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 32, 1916; Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 203, 1916; Vol. 10, p. 220, 1917; Howe, Vol. 14, p. 93, 1922; ? Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 550, 1922; Dall, Amer. Journ. Sci., Ser. 5, Vol. 4, p. 313, 1922.

Neptunea maxfieldi Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 219, pl. 6, fig. 54, Nov. 24, 1909, *fide* Dall, 1922.

Type specimens: Of both *imperialis* and *maxfieldi*, in the U. S. National Museum.

U. Miocene: Empire formation of Coos Bay, Oregon (Dall; Arnold and Hannibal; Howe); sea cliffs near Tahola, Washington (Arnold and Hannibal); Montesano of Washington (Weaver); Quillayute formation (Reagan), redeposited Empire; upper San Pablo, *Scutella breweriana* zone (Clark).

Pliocene: Jacalitos formation on Canoas Creek, etc., Coalinga district (Arnold); rare in the *Chione elsmerensis* zone (Nomland); ? Purisima formation, Pescadero Creek near the mouth of Jones Gulch and on the Halliday Ranch, Santa Cruz Mts. (Arnold, 1908); ? Merced formation a half mile north of Freestone, Sonoma County (Dickerson).

The difficulty with this species is that it was described from a badly worn specimen that does not show the sculpture nor the apertural characters. The species has been assigned to *Chrysodomus* because it resembles somewhat *Neptunea* (formerly called *Chrysodomus*) *satura* (Martyn). However, it is a rather peculiar form for *Neptunea* and the strong partitions across the suture suggest that it is more likely to belong to some genus like *Thais.* The specimen from the Purisima figured by Dall may not be the same species. Its form suggests *Ranella pacifica* (Dall). On the other hand, the figure given by Arnold (1910) seems to be of this species and is of a better preserved specimen, though the aperture is not showing. It resembles Clark's figure of *Thais ponderosa* variety *diabloensis.*[1] Stewart has recently shown that *ponderosa*[2] is probably more closely related to *Thais* than it is to *Forreria*, the genus recently separated off from *Trophon* that now contains the group of species with which *ponderosa* was formerly classed. It is not unlikely that *imperialis* is related to *ponderosa.* It must be admitted that these two species resemble some Miocene forms of *Forreria,* even that Arnold's figure has the shape of *Trophon geversianus*, the type of *Trophon*, though the shell is larger and much heavier. *Thais, Forreria,* and *Trophon* may intergrade in the early Miocene. The species *ponderosa* and *imperialis* differ from *Forreria* in lacking the angulation on the lower part of the body whorl and in having a shorter anterior canal. A specimen of *Thais* in the collection at the California Institute of Technology from the San Pablo formation resembles Clark's figure of *imperialis.* A specimen in the collection at Stanford University collected by Harold Hannibal from the Empire formation at the mouth of Maxfield Creek, Mora, Washington, has all the earmarks of *Thais.*

As *Purpura imperialis* Blainville has the apertural characters of *Stramonita,* though the shell seems to be smaller and thinner, with more spinose nodes, it may be necessary to use Reagan's name *maxfieldi.* Even should this species be transferred to the *wilkesanus* group, the name would be preoccupied by *Chicoreus* (*Phyllonotus*) *imperialis* (Swainson).

Subgenus **NUCELLA** Bolten, 1798

Nucella Bolten, Mus. Boltenianum, p. 54, 1798; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 48, 50, 1909; Dall, Proc. U. S. Nat. Mus., Vol. 49, pp. 557-563, 1915; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 386, 1927.

Type (by subsequent designation, Dall, 1909), *Nucella lapillus* Linnæus, figured by Reeve, Conch. Icon., Vol. 3, *Purpura*, pl. 10, figs. 47*a*, 47*b*, 1846; coasts of Europe.

Shell usually with a higher spire than typical *Thais*, and with spiral and axial sculpture both present, the latter sometimes well developed, or with both spiral and axial sculpture obsolete or nearly so.

Typical *Thais* has an anal notch in the aperture which is entirely lacking in *Nucella.* Dall (1915) has given a detailed description of *Nucella.*

Thais (Nucella) lamellosa (Gmelin)

Plate 32, Figures 14, 26

Buccinum plicatum Martyn, Univ. Conch., Vol. 2, pl. 44, 1788, not *B. plicatum* Linnæus, 1758.
Buccinum compositum Chemnitz, Conch. Cab., Vol. 10, p. 179, Vign. 21, figs. *a*, *b*, 1788, not strictly binomial.
Buccinum lamellosum Gmelin, Syst. Nat., Ed. 13, p. 3498, 1790; Bolten, Mus. Boltenianum, Ed. 1, p. 113, 1798.
Buccinum crispatum Chemnitz, *op. cit.*, Vol. 11, pp. 70, 84, pl. 187, figs. 1802, 1803, 1795, binomial ?

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[1] *Trophon ponderosum* Gabb variety *pabloensis* Clark (in text), *diabloensis* (in expl. of plate), Univ. Calif. Publ. Geol., Vol. 8, p. 500, pl. 66, fig. 5, 1915.

[2] *Trophon ponderosum* Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 2, pl. 1, fig. 3, 1866; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 499, pl. 66, figs. 3, 4, 1915; *Thais* (*Stramonita*) *ponderosa* (Gabb), Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 385, pl. 31, fig. 3, Jan. 3, 1927. Clark's figure 3 shows the type, which looks less like *Stramonita* than the specimen figured by Stewart. Clark's figures show that the anterior canals have somewhat the form of the anterior canal of the *wilkesanus* group.

Polyplex rugosus Perry, Conch., pl. 9, fig. 2, 1811.

Murex crispatus Lamarck, Hist. Anim. s. Vert., Vol. 7, p. 174, 1822.

Murex ferrugineus Eschscholtz, Zool. Atlas, Pt. 1, p. 10, pl. 9, figs. 2A, 2B, 1829.

Murex lactuca Eschscholtz, *op. cit.*, p. 11, pl. 9, figs. 3A, 3B, 1829, not of Bolten, *fide* Dall, 1915.

Polytropa crispata Lamarck, Swainson, Treat. Malac., p. 305, 1840.

Purpura septentrionalis Reeve, Conch. Icon., Vol. 3, *Purpura*, pl. 10, fig. 50, 1846.

Purpura (Polytropa) crispata Chemnitz, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 175, pl. 53, fig. 160, pl. 54, figs. 163-166, 168, 1880.

Purpura crispata Chemnitz, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 261, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 261, 1903; ? Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 121, pl. 6, fig. 57, 1909.

Thais (Nucella) lamellosa Gmelin, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 50, 1909; Proc. U. S. Nat. Mus., Vol. 49, p. 563, pl. 74, figs. 5, 6, 7, 8, 1915; U. S. Nat. Mus., Bull. 112, p. 111, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 42, pl. 38, figs. 1, 2, 4, pl. 35, fig. 7, 1927.

Thais plicata Martyn, Vanatta, Nautilus, Vol. 24, p. 37, 1910.

Thais crispata Chemnitz, Arnold, U. S. Geol. Surv., Bull. 396, p. 128, pl. 11, fig. 4, January 15, 1910; Bull. 398, pl. 33, fig. 4, 1910.

Thais etchegoinensis Arnold, U. S. Geol. Surv., Bull. 396, p. 142, pl. 18, fig. 2, January 15, 1910; Bull. 398, pl. 40, fig. 2, 1910.

Thais lamellosa Gmelin, Thompson, Rept. British Columbia Comm. Fisheries for 1912, p. I-42, pl. 9 (shell), pl. 10 (egg capsules), 1913; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917.

Thais lamellosa, var. *franciscana* Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 565, 1915; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 43, pl. 35, fig. 6, 1927.

Thais lamellosa, var. *hormica* Dall, *op. cit.*, p. 565, 1915; I. S. Oldroyd, *op. cit.*, p. 43, pl. 38, figs. 3, 5, pl. 35, fig. 8, 1927.

Thais lamellosa, var. *neptunea* Dall, *op. cit.*, p. 565, 1915; I. S. Oldroyd, *op. cit.*, p. 43, 1927.

Thais lamellosa, var. *cymica* Dall, *op. cit.*, p. 565, 1915; I. S. Oldroyd, *op. cit.*, p. 43, pl. 35, fig. 5, 1927.

Thais lamellosa, var. *sitkana* Dall, *op. cit.*, p. 566, 1915; I. S. Oldroyd, *op. cit.*, p. 44, 1927.

Thais (Nucella) nomeana Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 29, pl. 5, fig. 9, 1920.

Thais (Nucella) shumanensis Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 56, pl. 3, figs. 1, 2, 1926.

Miocene: Upper Miocene (Arnold, U. S. Geol. Surv., Bull. 396, p. 128, 1910).

Pliocene: Coos conglomerate of Coos Bay, Oregon; upper Wildcat of northern California; Merced and Purisima formations of middle California; Jacalitos and Etchegoin formations of San Joaquin basin; Pico formation near Ventura; Pacific Beach and Balboa Park Pliocene, San Diego (see references to California authors given above); etc.

Pleistocene: Santa Barbara to San Diego (Cooper); "Saugus" near Ventura (Waterfall); upper San Pedro series of San Pedro, Deadman Island, and Crawfish George's, Los Angeles County, "not common" (Arnold, 1903); etc.

Recent: Port Clarence, Bering Strait, to Aleutian Islands and south to Santa Barbara, California; also to Sado Island, Japan Sea (Dall, 1921).

This excessively variable species has been thoroughly overnamed. In the Oldroyd Collection at Stanford University there is a series of specimens showing all intermediate steps from smooth forms to those with strong axial frills and from small, low-spired individuals to large, high-spired individuals. This species affords a classic example of individual variation. The varietal names proposed by Dall (1915) have absolutely no systematic value.

Thais (Nucella) lima (Martyn)

Plate 32, Figure 15

Buccinum lima Martyn, Univ. Conch., Vol. 2, pl. 46, 1788.

Purpura saxicola Valenciennes, Voy. Venus, Atlas, p. 4, pl. 8, figs. 4, 4*a*, 1846; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 262, 1888; Keep, West Coast Shells, p. 31, fig. 11, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 261, 1903.

Purpura attenuata Reeve, Conch. Icon., Vol. 3, *Purpura*, pl. 10, fig. 49, 1846.

Purpura freycinetii Deshayes, Middendorff, Siber. Reise, Vol. 2, p. 219, pl. 12, figs. 5-9, 1851, in part, not of Deshayes, 1839.

Purpura (Polytropa) saxicola Valenciennes, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 174, pl. 53, figs. 152-154*a*, 1880.

Purpura lima Martyn, Anderson, Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 202, pl. 15, figs. 62, 63, 1905.

Thais lima Martin, Keep, West Amer. Shells, p. 180, fig. 169, 1911; Clark Univ. Calif. Publ. Geol., Vol. 8, p. 423, 1915.

Thais (*Nucella*) *lima* Martyn, Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 566, pl. 75, figs. 4, 5, 6, 1915; U. S. Nat. Mus., Bull. 112, p. 112, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 44, pl. 36, figs. 4, 5, 6, 1927.

Miocene: Middle Miocene of Kern River district (Anderson); upper and lower San Pablo formations, upper Miocene of middle California (Clark); Kirker's Pass, Mount Diablo region (Cooper).
Pliocene: Santa Rosa; San Fernando, Los Angeles County (Cooper).
Pleistocene: Pleistocene near Ventura; Santa Barbara; rare in upper San Pedro series at San Pedro (Arnold).
Recent: Arctic Ocean to Cedros Island, Lower California, Mexico; also to northern Japan (Dall, 1921).

This variable species has been in some confusion. It is likely that the above synonymy will need revision when the Pacific coast Nucellas are better known.

Thais (Nucella) emarginata (Deshayes)

? *Purpura lagenaria* Duclos, Ann. Sci. Nat., Vol. 26, p. 112, pl. 2, fig. 11, May, 1832, not of Lamarck, 1822, *fide* Dall, 1915.

Purpura emarginata Deshayes, Rev. Zool. Soc. Cuv., p. 360, 1839; Guerin's Mag. Zool., pl. 25, 1841; Reeve, Conch. Icon., Vol. 3, *Purpura*, pl. 10, fig. 46, 1846; Cook, Proc. Malac. Soc. London, Vol. 11, p. 203, 1915.

? *Purpura rupestris* Valenciennes, Voy. Venus, Atlas, pl. 9, figs. 1*a*, 1*b*, 1846, *fide* Dall, 1915.

Thais emarginata Deshayes, Vanatta, Nautilus, Vol. 24, p. 37, 1910 (but not his synonymy).

Thais (*Nucella*) *emarginata* Deshayes, Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 569, pl. 75, figs. 1, 2, 3, 1915; U. S. Nat. Mus., Bull. 112, p. 112, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 44, pl. 36, figs. 2, 3, 1927.

Pliocene: (See discussion below).
Recent: Bering Sea to Mazatlan and Topolobampo, Mexico.

It is quite probable that some of the records of fossil occurrence which have been assigned to *lima* in this catalogue should be included under *emarginata*. Until these variable species can be studied from abundant material (to measure the extent of individual variation) and the biologic units compared with original descriptions and figures, no useful contribution to our knowledge of them can be made.

Species of *Nucella* which have been reported only from the Pleistocene of Lower California, Mexico, have not been included here.

Thais (Nucella) canaliculata (Duclos)

Purpura canaliculata Duclos, Ann. Sci. Nat., Vol. 26, p. 104, pl. 1, fig. 1, May, 1832.

Thais (*Nucella*) *precursor* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 51, pl. 4, fig. 4, 1909.

Thais (*Nucella*) *canaliculata* Duclos, Dall, Proc. U. S. Nat. Mus., Vol. 49, p. 567, pl. 74, figs. 1-4, 1915; U. S. Nat. Mus., Bull. 112, p. 112, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 46, pl. 35, figs. 3, 4, 1927.

Pleistocene: Fossil Rock, Coos Bay, Oregon (Dall, as *precursor*).
Recent: Aleutian Islands to Monterey, California (Dall, 1921).

Thais (Nucella) collomi Carson

Thais (*Nucella*) *collomi* Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 57, pl. 4, figs. 1, 2, 1926.

Type specimen: In the collection at Stanford University, No. 111.

Type locality: Half mile north of Schuman, in Southern Pacific R. R. cut, Santa Maria district, Santa Barbara County, Pliocene.

Pliocene: At the type locality (Carson).

This is a very large species with scaly sculpture.

Thais (Nucella) elsmerensis, new species

Plate 32, Figure 13

Shell of small or moderate size, ovate, spire rather low and conical, body whorl large, aperture of moderate size, rather narrow, pillar nearly straight, the parietal wall with a callus wash; axial sculpture absent, spiral sculpture consisting of low, fine spiral cords, which are paired over part of the body whorl. Height 32 mm., width of body whorl 19 mm.

Type specimen: No. 299 in the collection of the San Diego Society of Natural History.

Type locality: S. D. S. N. H. locality 216, basal Pliocene east of Fernando Pass, Los Angeles County.

Pliocene: At the type locality; also from the basal Pliocene of Elsmere Canyon, Los Angeles County (H. R. G.).

The distinctive features of this shell are the wide, nearly straight pillar, the relatively narrow aperture, and the very low, fine spiral sculpture. *Thais emarginata* has low, but very much larger spirals or may be nearly smooth. Also, its columella is not so straight. *Thais canaliculata* usually has much more strongly developed spiral sculpture; but this feature appears to be very variable, and a few specimens have subdued spirals nearly like those of *elsmerensis.* However, *elsmerensis* can be distinguished even from such specimens of *canaliculata*, as it can from all other named California species, by its straighter columella, which means that the body whorl is less constricted toward the base. In time it may be found that *elsmerensis* should be considered a variety of one of the older, very variable species.

Genus ACANTHINA Fischer de Waldheim, 1807

Acanthina Fischer de Waldheim, Mus. Démidoff, Vol. 3, p. 174, 1807.
"*Acanthiza* Fischer," Gray, Proc. Zool. Soc. London for 1847, p. 138, 1847.

Type (by subsequent designation,[1] Gray, 1847), *Buccinum monoceros* Chemnitz, Conch. Cab., Vol. 10, p. 197, pl. 154, figures 1469, 1470, 1788; = *Buccinum calcar* Martyn, Univ. Conch., Vol. 1, fig. 10 and explanatory table, 1784; southern west coast of South America, Recent.

Shell short, with small spire, large body whorl, and very short anterior canal; spiral sculpture usually present but varices and axial sculpture absent; aperture ovate, parietal wall usually with a delimited callus deposit, a projecting tooth present at some growth stages on anterior portion of outer lip.

Acanthina lugubris (Sowerby)

Monoceros lugubre Sowerby, Genera of Shells, *Monoceros*, fig. 3, 1821; Conch. Illust., fig. 11, 1835; Tryon, Man. Conch., Ser. 1, Vol. 2, p. 193, pl. 60, fig. 291, 1880; Baker, Nautilus, Vol. 16, p. 40, 1912.
Acanthina lugubris Sowerby, Cooke, Proc. Malac. Soc. London, Vol. 13, p. 9, text fig. 7 (radula), also p. 10, 1918; Strong, Nautilus, Vol. 38, p. 22, 1924; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.
Acanthina (Acanthina) lugubris Sowerby, Dall, U. S. Nat. Mus., Bull. 112, p. 113, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 48, 1927.

Type locality: California, Recent.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: San Diego, California, to Magdalena Bay, Lower California, Mexico, and the Galapagos Islands (Dall).

This species has a strong anterior tooth projecting from the outer lip, a feature characteristic of *Acanthina* but not always developed.

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[1] The original description of *Acanthina* Fischer de Waldheim not being available, Gray's designation of type has been accepted tentatively without testing its validity. "*Acanthiza* Fischer" of Gray appears to be a pure error in spelling for *Acanthina*.

Section Acanthinucella Cooke, 1918

Acanthinucella Cooke, Proc. Malac. Soc. London, Vol. 13, p. 7, Sept. 9, 1918.

Type (by original designation), *Acanthina punctulata* Sowerby.

Acanthina spirata (Blainville)

Plate 32, Figures 6, 7, 8

Purpura spirata Blainville, Nouv. Ann. Mus. Paris, Vol. 1, p. 252, pl. 12, fig. 8, 1832.
Purpura engonata Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 264, pl. 20, fig. 17, 1837.
Monoceros engonatum Conrad, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 195, pl. 61, fig. 304, 1880; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 251, 1888; Keep, West Coast Shells, p. 29, fig. 10, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 246, 1903.
Acanthina (Acanthinucella) spirata Blainville, Dall, U. S. Nat. Mus., Bull. 112, p. 112, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 47, 1927.
Acanthina spirata Blainville, Strong, Nautilus, Vol. 38, p. 23, 1924.
Acanthina (Acanthinucalla) spirata Blainville, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: In the Paris Museum.

Type locality: "Des îles Sandwich" (an error presumably or based on a ballast shell).

Pleistocene: Barlow's Ranch, near Ventura (Arnold); "Saugus" formation near Ventura (Waterfall); S. D. S. N. H. locality 244, Las Posas zone, lower Pleistocene in Sexton Canyon, Ventura County; Lake Merced, San Mateo County, and all the lower and upper San Pedro series localities in the San Pedro district (Arnold); S. D. S. N. H. locality 78, upper Pleistocene terrace near Seacliff station, about eight miles northwest of Ventura.
Recent: Puget Sound to San Diego, California, and Socorro Island, Lower California, Mexico (Dall, 1921).

The typical variety of *spirata* has been confused with varieties *punctulata* and *unicarinata*. It is possible that the California Pleistocene shell referred to above should be called *Acanthina spirata* var. *unicarinata* (Sowerby).[1]

Acanthina spirata (Blainville) variety **punctulata** (Sowerby)

Monoceros punctulatum Sowerby, Conch. Illust., *Monoceros*, fig. 3, 1835.
Monoceros lapilloides Conrad, Journ. Acad. Nat. Sci. Phila., Vol. 7, p. 265, pl. 20, fig. 18, 1837; Tryon, Man. Conch., Ser. 1, Vol. 2, p. 195, pl. 61, fig. 305, 1880; Keep, West Coast Shells, p. 28, fig. 9, 1888, 1892; Cooper, Calif. State Mining Bureau, Bull. No. 4, Pt. 3, p. 28, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 247, 1903.
Acanthinucella punctulata (Sowerby), Cooke, Proc. Malac. Soc. London, Vol. 13, pp. 8, 10, text fig. 3, p. 9 (radula), 1918.
Acanthina lapilloides Carpenter, E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919.
Acanthina (Acanthinucella) spirata punctulata Sowerby, Dall, U. S. Nat. Mus., Bull. 112, p. 113, 1921.
Acanthina spirata var. *punctulata* Sowerby, Strong, Nautilus, Vol. 38, p. 21, 1924.

Pleistocene: Ventura County (Cooper); "rare in upper San Pedro series of San Pedro; one specimen" (Arnold); chiton bed on Point Firmin, near San Pedro (Chace).
Recent: Monterey, California, to San Thomas, Lower California, and Socorro Island, Mexico (Dall, 1921).

Genus TROPHON Montfort, 1810

Trophon Montfort, Conchyl. Syst., Vol. 2, p. 483, 1810.

Type (by original designation), *Trophon magellanicus* (Gmelin), = *Buccinum geversianum* Pallas, figured by Reeve, Conch. Icon., Vol. 4, *Fusus*, pl. 4, fig. 2, 1847, by H. and A. Adams, Gen. Rec. Moll., Vol. 3, pl. 8, fig. 3*c*, 1855, by Sowerby, Thes. Conch., Vol. 4, *Trophon*, p. 59, pl. 2, figs. 7, 8, 1880, and by Tryon, Man. Conch., Ser. 1, Vol. 2, p. 144, pl. 32, fig. 339, 1880; Straits of Magellan to Chile, Recent.

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[1] Strong, Nautilus, Vol. 38, pp. 18, 104, 1924.

Shell fusiform, sometimes stout, with oval or round aperture, more or less long, somewhat bent, open anterior canal, and axial and in most cases spiral sculpture.

The type of the genus *Trophon* is a rather stout shell with large body whorl and nearly round aperture, a moderately long, somewhat bent anterior canal and partially open umbilicus. It has numerous but distant, lamellar, varix-like axial ribs, which are pointed on the shoulder of the whorls.

"Trophon" ponderosum Gabb, of the California Miocene, is a *Thais.*

Subgenus **BOREOTROPHON** Fischer, 1884

Boreotrophon Fischer, Man. de Conchyl., p. 640, 1884.

Type (by monotypy), *Trophon clathratus* (Linnæus), figured by Tryon, Man. Conch., Ser. 1, Vol. 2, p. 140, pl. 31, fig. 312, 1880, northern coasts of Europe.

Shell somewhat fusiform, with long, slender anterior canal, axial ribs not developed into prominent lamellæ and without long spines on the shoulder of the whorls; spiral sculpture absent or faint.

Boreotrophon Fischer takes the place of *"Neptunea* Bolten," as erroneously used by Dall.

The following is an alphabetical list of species of *Boreotrophon* which have been reported from the Pliocene and Pleistocene formations of California and of some other localities in western North America.

Trophon (Boreotrophon) beringi (Dall)

Boreotrophon beringi Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 544, March 31, 1902.
Neptunea beringi Dall, Canadian Arctic Expedition, Vol. 8, Pt. A, p. 26A, 1919.
Trophon (Neptunea) beringi Dall, U. S. Nat. Mus., Bull. 112, p. 109, pl. 10, fig. 6, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 33, pl. 30, fig. 6, also Pt. 1, pl. 18, fig. 8, 1927.

Type specimen: In the U. S. National Museum, No. 109,051.

Type locality: Bering Sea.

Pleistocene: South side of Herschel Island, Yukon Territory (Dall, 1919).
Recent: Icy Cape, Arctic Ocean, to Puget Sound; Japan (Dall, 1921).

This species is very similar to *clathratus,* the type of the subgenus *Boreotrophon* Fischer.

Trophon (? Boreotrophon) cerritensis Arnold

Trophon (Boreotrophon) cerritensis Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 249, pl. 6, fig. 6, 1903.
Neptunea cerritensis Arnold, Dall, U. S. Nat. Mus., Bull. 112, p. 111, 1921.

Type specimen: In the U. S. National Museum, No. 162,545.

Type locality: Deadman Island, off San Pedro, Los Angeles County, Pleistocene.

Pleistocene: Lower San Pedro series at Deadman Island, one adult and five juvenile specimens; also one from Los Cerritos; both Los Angeles County (Arnold).

This is a large species, well figured by Arnold. Dall (1921) classified it in the section *Trophonopsis;* but although the specimen figured by Arnold appears to be much worn, its characters suggest a relationship with the *orpheus* and *stuarti* group rather than with *Trophonopsis.*

Trophon (Boreotrophon) fleenerensis (Martin)

Boreotrophon fleenerensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 191, pl. 22, figs. 3*a*, 3*b*, 3*c*, August 6, 1914.

Type specimen: In the collection at the University of California.

Type locality: Two miles south of Centerville, Humboldt County, California, Pliocene.

Pliocene: Two miles south of Centerville, Humboldt County, abundant in upper portion of the Wildcat series (Martin).

Trophon (Boreotrophon) multicostatus (Eschscholtz)

Murex multicostatus Eschscholtz, Zool. Atlas, Pt. 2, p. 11, pl. 4, fig. 4, 1829.
? "*Trophon gunneri* Lovén," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 663, 1864, not of Lovén, 1846.
? "*Boreotrophon gracilis* Perry," Berry, Nautilus, Vol. 22, p. 38, 1908, not of Perry.
? "*Trophon gracilis* Perry," Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917; and of other Pacific coast authors, not of Perry, 1801.
Neptunea multicostata Eschscholtz, Dall, U. S. Nat. Mus., Bull. 112, p. 110, pl. 13, fig. 1, 1921.
Trophon (*Neptunea*) *multicostatus* Eschscholtz, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 33, pl. 33, fig. 11, 1927.
Trophon (*Neptunea*) *multicostata* Eschscholtz, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type locality: Sitka, Alaska, Recent.

Pliocene: Pecten coalingensis zone, middle Etchegoin of Coalinga region (Nomland); Bath-house Beach, uppermost Pliocene, Santa Barbara (Arnold; Berry).

Pleistocene: "Pliocene" and lower San Pedro series of Deadman Island, Los Angeles County, "rare" (Arnold); "Saugus" formation near Ventura (Waterfall).

Recent: Nunivak Island, Bering Sea, to San Pedro, California; also northern Japan (Dall, 1921).

Arnold's figure of *multicostatus* is really *Trophon* (*Boreotrophon*) *pacificus* (Dall).

Trophon (Boreotrophon) orpheus (Gould)

Plate 32, Figure 9

Fusus orpheus Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 142, 1849; U. S. Explor. Exped., Vol. 12, p. 234, 1852, Atlas, pl. 16, figs. 285, 285*a*, 285*b*, 1856.
Trophon orpheus Gould, Crosse, Journ. de Conchyl., Vol. 25, p. 103, 1877; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 268, 1888; Newcombe, Bull. Nat. Hist. Soc. Brit. Columbia, p. 70, 1893.
Boreotrophon orpheus Gould, Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 542, 1902.
Trophon (*Neptunea*) *orpheus* Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 110, pl. 6, fig. 7, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 37, pl. 30, fig. 14, 1927.

Type specimen: In the collection of the Boston Society of Natural History or in the U. S. National Museum ?

Type locality: Puget Sound, Recent.

Pliocene: San Diego well, middle Pliocene, San Diego (Cooper); S. D. S. N. H. locality 218, upper Pliocene (Santa Barbara zone) of Sulphur Canyon east of South Mountain, Ventura County (H. R. G.).

Pleistocene: San Pedro; San Diego (Cooper, probably including Arnold's variety *præcursor*).

Recent: Victoria, British Columbia, and off the Columbia River, Oregon (Dall, 1921).

Trophon (*Boreotrophon*) *orpheus* (Gould) has sometimes been confused with *T.* (*B.*) *stuarti* (Smith), which is a larger species with fewer but more accentuated, sub-lamellar axial ribs. The recent figure of *orpheus* given by Dall (and reproduced by Oldroyd, who figures both species) will assist in distinguishing the two.

Trophon (**Boreotrophon**) **orpheus** (Gould) variety **pedroanus** Arnold

Trophon (*Boreotrophon*) *pedroana* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 251, pl. 6, fig. 12, 1903.
Neptunea pedroana Arnold, Dall, U. S. Nat. Mus., Bull. 112, p. 111, 1921.

Type specimen: In the U. S. National Museum.

Type locality: Deadman Island, Los Angeles County, lower Pleistocene.

Pleistocene: Lower San Pedro series at San Pedro and Deadman Island, "rather common"; upper San Pedro series at Crawfish George's, Los Angeles County (Arnold).

The shell of this species is like that of an eroded *orpheus,* but the whorls are more evenly rounded and there are but three widely spaced spiral ribs. Arnold's variety *præcursor* (of *orpheus*) may be a synonym. It is probable that *pedroanus* itself is only a variant of *orpheus.* In any case it is evident that the species of this group need revision so that the unnecessary names can be eliminated.

Trophon (**Boreotrophon**) **orpheus** (Gould) variety **præcursor** Arnold

Trophon (*Boreotrophon*) *stuarti* Smith, var. *præcursor* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 253, pl. 6, fig. 5, 1903.

Type specimen: In the U. S. National Museum, No. 162,546.

Type locality: Deadman Island, Los Angeles County, Timms Point zone, lower Pleistocene.

Pliocene: Bath-house Beach, Santa Barbara, uppermost Pliocene (Arnold).
Pleistocene: "Not uncommon" in the "Pliocene" and the lower San Pedro series of Deadman Island, Los Angeles County (Arnold).

This very close variety is more slender and has less sharply defined sculpture (eroded ?) than typical *orpheus.* It also resembles *pedroanus.*

Trophon (**Boreotrophon**) **pacificus** (Dall)

"*Trophon multicostatus* Eschscholtz" of some California conchologists, in part, not of Eschscholtz.
Boreotrophon pacificus Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 544, March 31, 1902.
"*Trophon* (*Boreotrophon*) *multicostatus* Eschscholtz," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 251, pl. 6, fig. 9, 1903.
"*Trophon* (*Boreotrophon*) *scalariformis* Gould," Arnold, *op. cit.*, p. 252, pl. 6, fig. 10, 1903, not of Gould.
Neptunea pacifica Dall, U. S. Nat. Mus., Bull. 112, p. 110, pl. 11, fig. 5, 1921.
Trophon (*Neptunea*) *pacificus* Dall, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 35, pl. 30, fig. 4, 1927.

Type specimen: In the U. S. National Museum, No. 109,100.

Type locality: Bering Sea ?

Pleistocene: "Pliocene" of Deadman Island, lower and upper San Pedro series of San Pedro region (Arnold).
Recent: "Arctic Ocean southward, on the west to Kamchatka and on the east in deep water to Acapulco, Mexico." (Dall, 1921.)

Arnold's figures of both *multicostatus* and *scalariformis* probably represent this species.

Trophon (**? Boreotrophon**) **perelegans** Nomland

Trophon perelegans Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 311, pl. 20, figs. 1, 2, 3, November 8, 1917.

Type specimen: In the collection of the California Academy of Sciences, No. 11,321.

Type locality: About eleven miles northeast of Coalinga, Fresno County, upper Miocene.

Miocene: At the type locality, Santa Margarita formation northeast of Coalinga; Nacimiento River, eight miles west of San Miguel, San Luis Obispo County; Vineyard Creek anticline, Monterey County (Nomland).

This species has some of the aspects of a small *Forreria.*

Trophon (Boreotrophon) raymondi Moody

Trophon raymondi Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 53, pl. 1, figs. 1*a*, 1*b*, October 11, 1916.

Type specimen: In the collection at the University of California, No. 11,088.
Type locality: Fourth and Broadway, Los Angeles, Pliocene.

Pliocene: Lower part of the upper Pliocene at the type locality (Moody); also from the same horizon at Fifth and Hope streets, Los Angeles (coll. by Charles M. Jay).

This form is very similar to and is probably the precursor of *Trophon* (*Boreotrophon*) *eucymatus* Dall,[1] from which it differs in having a lower spire and less gracefully tapering body whorl. *T. raymondi* has a more cubic appearance because of its lower spire and the constriction or abrupt tapering of the lower portion of the body whorl. *Trophon bentleyi* Dall[2] is also similar; but it has a longer anterior canal than either of the others, and the varices project upward to form a more pronounced spinose coronation on the tabulation of the body whorl. How much importance these characters have for specific distinctions can be determined only by a study of a large series of specimens.

Trophon (Boreotrophon) stuarti Smith

Trophon stuarti E. A. Smith, Proc. Zool. Soc. London for 1880, p. 481, pl. 48, fig. 6, 1880.
Boreotrophon (*stuarti* var. ?) *smithi* Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 542, 1902.
"*Trophon* (*Boreotrophon*) *gracilis* Perry," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 250, pl. 6, fig. 8, 1903, not *Polyplex gracilis* Perry, Conch., pl. 9, fig. 4, 1801.
Trophon (*Boreotrophon*) *stuarti* Smith, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 252, pl. 6, fig. 4, 1903; U. S. Geol. Surv., Bull. 396, p. 156, pl. 25, fig. 2, January 15, 1910; Bull. 398, pl. 47, fig. 2, 1910.
Boreotrophon stuarti Smith, Berry, Nautilus, Vol. 22, p. 38, 1908.
Trophon (*Neptunea*) *stuarti* Smith, Dall, U. S. Nat. Mus., Bull. 112, p. 111, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 38, pl. 33, fig. 13, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.
Trophon (*Neptunea*) *smithi* Dall, U. S. Nat. Mus., Bull. 112, p. 111, pl. 13, fig. 8, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 38, pl. 33, fig. 14, 1927.

Type locality: Vancouver Island, British Columbia, Recent.

Pliocene: Etchegoin formation of Coalinga region (Arnold, 1910); Bath-house Beach, Santa Barbara, upper Pliocene (Berry); San Diego well (Arnold, 1903).
Pleistocene: "Pliocene" of Deadman Island and Timm's Point and lower San Pedro of Deadman Island, Los Angeles County (Arnold, 1903).
Recent: Shumagin Islands, Alaska, to San Diego, California.

Polyplex gracilis Perry, as figured by that author, has about twice as many axial ribs as the specimen figured by Arnold. Perry gave the habitat of *gracilis* as "New Zealand."

Trophon (? Boreotrophon) triangulatus Carpenter

Trophon triangulatus Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 663, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 224, February, 1866; Tryon, Man. Conch., Ser. 1, Vol. 2, p. 142, 1882; ? Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 268, 1888; Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 180, in part, pl. 5, fig. 3 only, 1891.
? *Trophon* (*Boreotrophon*) *triangulatus* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 254, in part, 1903.
Trophon (*Austrotrophon*) *triangulatus* Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 109, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 28, pl. 34, figs. 6, 7, 1927.

Type specimen: In the State Collection, No. 580*a*, University of California.
Type locality: Off Catalina Island, California.

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[1] Proc. U. S. Nat. Mus., Vol. 24, p. 547, 1902, type locality 124 fathoms off San Diego; figured in Bull. 112, U. S. Nat. Mus., pl. 15, fig. 7 1921.

[2] Proc. U. S. Nat. Mus., Vol. 34, p. 249, 1908, type locality, off San Diego harbor, in 20 fathoms, mud. *Trophon tripherus* Dall, as figured (U. S. Nat. Mus., Bull. 112, p. 111, pl. 15, figs. 8, 9, 1921) is also similar, but we have not seen specimens.

Pleistocene: Santa Barbara (Cooper); lower San Pedro series of Deadman Island, Los Angeles County, "rare" (Arnold).
Recent: Catalina Island and San Pedro, California (Dall, 1921).

This is a small species, the type, which is figured by Dall (1891) and by Oldroyd (1927), being about 10 mm. long. It has been confused with the species now known as *Forreria catalinensis* (Oldroyd); but it is very much smaller, is clearly not the young of that species, and may not even be related to *Austrotrophon.* It may be an early name for some species of *Boreotrophon* now known by a later name.

Subgenus **TROPHONOPSIS** Bucquoy, Dautzenberg, and Dollfus, 1882

Trophonopsis Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 40, 1882.

Type (by original designation), *Murex muricatus* Montagu, Test. Brit., p. 262, pl. 9, fig. 2, 1803 (+ *Murex variabilis* Christofori and Jan., 1832, + *Fusus echinatus* Sowerby, Philippi, Enum. Moll. Sic., Vol. 1, p. 200, pl. 11, fig. 10, Vol. 2, p. 179, 1836-44, + *Fusus longurio* Weinkauff, Journ. de Conchyl., Vol. 14, p. 244, pl. 5, fig. 4, 1868, *fide* Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 39, figured on pl. 6, fig. 7, 1882), Mediterranean, Atlantic coasts of Europe, possibly to northeastern North America, Recent, also Pliocene of England.

Shell like that of *Boreotrophon* but with prominent spiral sculpture and secondary axial sculpture.

Trophon (Trophonopsis) tenuisculptus Carpenter

Trophon tenuisculptus Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 17, p. 277, 1866; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 70, 1868-9; Cooper, 7th Ann. Rept., Calif. State Mineralogist, p. 268, 1888.
Trophon (*Boreotrophon*) *tenuisculptus* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 253, 1903.
Boreotrophon tenuisculpta Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 24, p. 541, 1902; Van Winkle, Bull. Amer. Paleo., Vol. 8, p. 351, pl. 1, figs. 6-9, 1921 (figure of type specimen).
Neptunea tenuisculpta Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 111, pl. 11, figs. 11, 12, 1921.
Trophon (*Neptunea*) *tenuisculptus* Carpenter, Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 39, pl. 30, figs. 3, 7, 1927.

Type specimen: At Cornell University, Ithaca, New York.

Type locality: Santa Barbara, fossil, said to be Pleistocene, but quite likely to be upper Pliocene (Santa Barbara zone).

? U. Pliocene: Type locality (?).
Pleistocene: "Pliocene" of San Pedro district, "rare" (Arnold); Santa Barbara (Carpenter).
Recent: Southeastern Bering Sea to Todos Santos Bay, Lower California, Mexico (Dall, 1921).

Genus **FORRERIA** Jousseaume, 1880

Forreria Jousseaume, Le Naturaliste, 2nd year, No. 42, p. 335, December 15, 1880.[1]
"*Chorus* Gray," of various authors, not of Gray, Proc. Zool. Soc. London for 1847, p. 136, 1847, type by original designation, *Monoceros giganteus* Lesson.

Type (by original designation) *Murex belcheri* Hinds.

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[1] In this short article, Jousseaume lists forty-seven genera, subgenera, and sections of the Muricids, stating their type species in each case. The following are given as new: *Tubicauda*, type, *Murex brevispina* Lamarck; *Siratus*, type, *Purpura sirati* Adanson; *Paziella*, type, *Murex pazi* Crosse; *Poirieria*, type, *Murex zelandicus* Quoy and Gaimard; *Naquetia*, type, *Murex triqueter* Born; *Inermicosta*, type, *Murex fasciatus* Sowerby; *Favartia*, type, *Murex breviculus* Sowerby; *Euphyllon*, type, *Murex monodon* Sowerby; *Ocinebrellus*, type, *Murex eurypteron* Reeve; *Gracilipurpura*, type, *Fusus strigosus* Lamarck; *Ocinibrina*, type, *Fusus coralinus* Scacchi; *Hanetia*, type, *Murex haneti* Petit; *Crassilabrum*, type, *Murex crassilabrum* Gray; *Forreria*, type, *Murex belcheri* Hinds; *Jatova*, type, *Purpura jatova* Adanson; *Pteropurpura*, type, *Murex macropterum* Deshayes; *Pterochelus*, type, *Murex acanthopterus; Marchia*, type, *Murex clavus* Kiener; *Purpurellus*, type, *Murex gambiensis* Reeve; *Poropteron*, type, *Murex tubifer; Typhinellus*, type, *Typhis sowerbyi* Broderip; *Typhina*, type, *Typhis belcheri* Broderip; *Siphonochelus*, type, *Typhis arcuatus* Hinds; *Typhisopsis*, type, *Typhis coronatus* Broderip; *Haustellotyphis*, type, *Typhis cumingi* Broderip; *Perotyphis*, type, *Typhis pinnatus* Broderip. The last one is on page 336. Unfortunately, Jousseaume's paper was received too late to be used by the authors in studying the *Muricidæ*.

Subgenus **AUSTROTROPHON** Dall, 1902

Austrotrophon Dall, Proc. U. S. Nat. Mus., Vol. 24, pp. 534, 548, March 31, 1902.

Type (here designated), *Trophon cerrosensis* Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 181, pl. 5, figs. 5, 7, 1891.[1]

Shell of moderate size, with produced anterior canal, numerous lamellar varices which are prolonged into points or spines on the shoulder of the whorls; spiral sculpture absent or weak.

The peculiar leaf-like lamellæ, which appear as if wrapped around the shell, sufficiently characterize this subgenus. The shell is of a light brownish color, which also appears to be characteristic of *Forreria, s. s.*

Forreria (Austrotrophon) catalinensis (Oldroyd)

'*Trophon triangulatus* Carpenter," Dall, Proc. U. S. Nat. Mus., Vol. 14, p. 180, in part, pl. 5, figs. 1, 6, not fig. 3, 1891, not of Carpenter.

"*Trophon* (*Boreotrophon*) *triangulatus* Carpenter," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 254, 1903, not of Carpenter.

"*Trophon* (*Austrophon*) *triangulatus* Carpenter," Dall, U. S. Nat. Mus., Bull. 112, p. 109, in part, 1921, not of Carpenter.

Trophon (*Austrotrophon*) *catalinensis* I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 29, pl. 34, figs. 1-5, 1927.

Type specimen: In the collection at Stanford University.

Type locality: Off San Pedro, California, in 25 fathoms.

Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles County, "rare" (Arnold, as *T. triangulatus*).

Recent: Catalina Island and San Pedro, California.

Forreria catalinensis (Oldroyd) is very much larger than *Trophon triangulatus* Carpenter, with which it was for so long confused. It is probable that Cooper's report of Carpenter's species in the Pleistocene at Santa Barbara refers to *T. catalinensis*, but there is no way of deciding this point. *Forreria* (*Austrotrophon*) *cerrosensis* (Dall) is closely related but has more lamellar frills (about 10 per whorl instead of 6 or 7), and is usually smaller. The type of *F. catalinensis* is 100 mm. in length, has seven sharp lamellar frills and no spiral sculpture. A closely related or identical species occurs in the San Diego Pliocene (Hertlein and Grant, MS.).

F. catalinensis differs from *belcheri* in having a much narrower body whorl anteriorly, in lacking the constriction in the middle of the body whorl of that species, and in its more extended lamellæ.

Subgenus **FORRERIA**, s. s.

Forreria belcheri (Hinds)

Murex belcheri Hinds, Proc. Zool. Soc. London for 1843, p. 127, March, 1844; Zool. Voy. Sulphur, Moll., p. 8, pl. 2, figs. 1, 2, 3, 1844.

Pyrula belcheri Hinds, Reeve, Conch. Icon., Vol. 4, *Pyrula*, pl. 2, fig. 4, 1847.

Chorus belcheri Hinds, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 198, pl. 61, fig. 309, 1880; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 235, 1888; Keep, West Coast Shells, p. 25, fig. 7, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 247, 1903; Orcutt, Molluscan World, p. 6, 1915.

Forreria belcheri Hinds, Dall, U. S. Nat. Mus., Bull. 112, p. 113, 1921; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; Jordan and Hertlein, Vol. 15, p. 419, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 49, pl. 32, figs. 2, 5, 1927.

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[1] The type locality is off Cedros Island, Lower California, Mexico, in 12 to 48 fathoms, mud and sand. Mr. George Willett, of the Los Angeles Museum, has collected this species in 30 fathoms off Catalina Island, California.

Type locality: San Diego, California, Recent.

Pliocene: San Diego well (Dall); Rustic Canyon, Santa Monica (coll. by Carson; possibly Pleistocene ?); Turtle Bay, Lower California, Mexico (Jordan and Hertlein).

Pleistocene: Barlow's Ranch, near Ventura; upper San Pedro series at Crawfish George's, Los Cerritos, and San Pedro, Los Angeles County, "rare" (Arnold).

Recent: San Pedro, California, to Scammon's Lagoon, Lower California, Mexico (Dall, 1921).

Forreria belcheri (Hinds) is a rather large shell with quadrate whorls handsomely coronated with hollow, trough-like spines. The body whorl is rather abruptly constricted anteriorly, a slight sulcus being reflected at the aperture by a projecting tooth on the outer lip, as in *Pseudoliva.* In general aspect the shell recalls *Forreria catalinensis* (I. S. Oldroyd), but the thin, expanded varices of the latter are in *belcheri* closely welded to the sides of the whorl and the shell of Hinds' species is heavier, more quadrate in shape, and has a relatively shorter and more bent anterior canal and a more open umbilicus. The genus *Forreria* may be related to *Trophon* through such species, that is, via *Austrotrophon.*

Forreria belcheri (Hinds) variety **avita** (Nomland)

"*Trophon* (*Forreria*) *ponderosum* Gabb," Arnold, U. S. Geol. Surv., Bull. 396, p. 134, pl. 14, figs. 3, 5, 6, January 15, 1910; Bull. 398, pl. 36, same figures, 1910, not *Trophon ponderosum* Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 2, pl. 1, fig. 3, 1866, =*Thais* (*Stramonita*) *ponderosa* (Gabb).

"*Trophon ponderosus* Gabb," McLaughlin and Waring, Map folio accompanying Bull. 69, Calif. St. Mining Bureau, pl. 1, fig. 41, 1914.

Trophon belcheri avitum Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 237, pl. 11, fig. 5, April 19, 1917.

Type specimen: In the collection of the University of California, No. 11,094.

Type locality: In the Coalinga region, San Joaquin basin, California, Pliocene.

Pliocene: Rare in the *Turritella nova* zone, lower part of the Etchegoin of the Coalinga region (Nomland).

There is very little difference between this variety and typical *belcheri,* aside from the imperfections due to erosion and weathering.

Forreria magister (Nomland)

Plate 27, Figures 14*a*, 14*b*

Trophon magister Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 207, pl. 11, figs. 4*a*, 4*b*, 4*c*, February 24, 1916.

Type specimen: In the collection at the University of California.

Type locality: On Jacalitos Creek or Waltham Creek, Coalinga district, California, lower Pliocene.

Pliocene: Jacalitos formation in the Coalinga district (Nomland); S. D. S. N. H. locality 203, lower Pliocene of Elsmere Canyon, Los Angeles County (H. R. G.).

This is a large, massive, rude species with broad, low nodosities on the shoulder of the whorls and a deep constriction on the anterior portion of the body whorl.

Forreria carisaënsis (Anderson)

Chorus carisaënsis F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 2, p. 206, pl. 17, figs. 90, 91, December 4, 1905.

Trophon carisaënsis Anderson, Arnold, U. S. Geol. Surv., Bull. 396, pl. 10, fig. 4, January 15, 1910; Bull. 398, pl. 32, fig. 4, 1910; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 497, pl. 66, figs. 1, 2, 1915; Nomland, Vol. 10, pp. 299, 301, 1917.

Type specimen: In the collection at the California Academy of Sciences, if not lost in the San Francisco earthquake.

Type locality: Near La Panza Springs, San Luis Obispo County, lower Pliocene.

Miocene: Questionably the "Vaqueros-Temblor" (Nomland); San Pablo formation north of Mount Diablo, Las Trampas, and Rocky Ridges (Clark); Santa Margarita formation, upper Miocene of Coalinga district (Arnold; Nomland).

Pliocene: "Lower Etchegoin beds of the Mount Diablo Range, near La Panza Springs, San Luis Obispo County" (Anderson).

Forreria carisaënsis (Anderson) is larger and has fewer but much more prominent nodes on the shoulders of the whorls than has *Chicoreus wilkesanus.* Some of the later names, such as *coalingensis, magister,* and *avita,* may later be found to be synonyms.

Forreria wrighti Jordan and Hertlein

Forreria wrighti Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 448, pl. 32, figs. 1, 3, July 22, 1926.

Type specimen: At the California Academy of Sciences, No. 2123.

Type locality: Southeast of Turtle Bay, Lower California, Mexico, Pliocene.

Pliocene: Southeast of Turtle Bay, Lower California, Mexico (Jordan and Hertlein).

This species has spiral riblets which are particularly emphasized on the whorls of the spire in addition to axial sculpture which produces a crown of spines on the shoulders.

Forreria coalingensis (Arnold)

Trophon (Forreria) coalingense Arnold, U. S. Geol. Surv., Bull. 396, p. 87, pl. 22, fig. 4, January 15, 1910; Bull. 398, pl. 44, same figure, 1910.

Trophon coalingense Arnold, Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 203, 1916; Vol. 10, p. 221, 1917.

Type specimen: In the U. S. National Museum, No. 165,540.

Type locality: Extreme southeastern end of Kettleman Hills, San Joaquin basin, California, Pliocene.

Pliocene: Jacalitos formation of Jacalitos and Waltham canyons, Coalinga district, lower Pliocene (Nomland, 1916); Etchegoin formation on south side of Garza Creek and at southeastern end of Kettleman Hills, Coalinga district (Arnold); "rare" in the *Chione elsmerensis* zone, lower Pliocene of the Coalinga region (Nomland, 1917).

Genus CHICOREUS Montfort, 1810

Chicoreus Montfort, Conch. Syst., Vol. 2, p. 611, 1810.

Triplex Perry, Arcana, pl. 23, June, 1810, type (by monotypy), *Triplex foliatus* Perry, pl. 23, 1810, + *Triplex rosaria* Perry, Conchology, pl. 6, fig. 3, April, 1811, + *Murex palmarosæ* Lamarck; Matthews and Iredale, Victorian Naturalist, Vol. 29, p. 11, 1912.

Type (by original designation), *Murex ramosus* Linnæus, Syst. Nat., Ed. 10, p. 747, 1758; figured by Reeve, Conch. Icon., Vol. 3, *Murex,* pl. 1, species 3, April, 1845; Recent, in the Orient.

Shell large, stout; sculpture of three or more lamellar varices, sometimes spiny; anterior canal rather short, strongly recurved, partly covered by a flap.

Distribution: Warm waters.

Montfort's figure of *C. ramosus* is rather elongate for that species; but even if it should represent a different, though closely allied species, it could not affect the use of the genus name. *C. ramosus* is clearly congeneric with the type of *Phyllonotus.* It has three varices with strong lamellar spines and three without, whereas *Phyllonotus* has six or more varices which are apt to be all alike, either without spinous lamellæ or with only moderate ones. In other characteristics the two agree, and the distinction is at most subgeneric, perhaps only sectional. The new group, *Murithais*, has small, simple nodes on the angle and occasionally smaller ones below, but the varices are hardly more than indistinct axial ribs, dying out downward. It is distinguished from *Forreria* by the lack of the angulation on the lower part of the body whorl and by the more compact form of its nodes. As it seems to be most like *Forreria*, it will be considered ahead of *Phyllonotus*.

Phyllonotus and *Muricanthus* are even more closely related to typical *Chicoreus* than is *Murithais* and should probably be separated only as sections, if at all. Perry's name, *Triplex*, may be older than *Chicoreus*.

Subgenus **MURITHAIS**, new subgenus

Type, Murex trunculus Linnæus, Syst. Nat., Ed. 10, p. 747, 1758; good figures by Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 18, pl. 1, figs. 3, 4, 1882; the figures by Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 5, species 22, May, 1845, are more ornate than is usual for this variable species; Mediterranean, Recent.

Shell like that of *Phyllonotus* but usually smaller, with shorter anterior canal, less distinct varices, and more compact nodes.

This group seems to be equally difficult to distinguish from several well-known groups that are ordinarily not considered very much alike. It is most closely allied to *Chicoreus* and *Phyllonotus*, as noted above; but it is also connected with *Thais* through such species as *T. ponderosa*. Indeed, *ponderosa* as figured by Clark is so very much like *wilkesanus* that it seems not unlikely that *ponderosa* and perhaps also Dall's *imperialis* should be transferred to this group. On the other hand, Miocene species of *Forreria* approach very closely to *wilkesanus* and appear also to be closely related. Immature specimens of *topangensis* (Arnold)[1] in the collection at the Los Angeles Museum from the Santa Monica Mountains bear such a striking resemblance to Recent specimens from Ceylon of *Cantharus tranquebaricus*, the type of *Cantharus*, in size, shape, and sculpture that the writers did not see any characters by which to distinguish them. In this case the relationship may not be so close, for the adults of *topangensis* lose somewhat their resemblance to *tranquebaricus* and show that *topangensis* is either a synonym or a species closely related to *wilkesanus*. Some of the west American species of *Cantharus* look less like *tranquebaricus* than does the young of *topangensis* and perhaps some of them are more nearly allied to *Searlesia*, especially *humerosus;* but they are connected with *tranquebaricus* through such species as *anomalus*. This case is one of the many disconcerting connections between the *Neptuneidæ* and the *Muricidæ*. Some writers explain the resemblances as due to the coincidences of parallel development; but the more of these coincidences appear between two particular groups, the less plausible this explanation becomes. Arnold described his *topangensis* as an *Ocinebra* (now known as *Tritonalia*), and he had good reason to see the close relationship of his species to that group. But the most striking and most significant resemblance is between *wilkesanus* and *trunculus*. The latter has more tabulated whorls than the specimen of *wilkesanus* figured here, but Anderson's type shows stronger tabulations. *Siratus* Jousseaume[2] is intermediate between *trunculus* and the true *Murex* and not very far from either. Its anterior canal is much longer than that of *trunculus* and it tends to be more spinose. Clearly there are links between all the *Muricidæ*.

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[1] *Ocinebra topangensis* Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 530, pl. 43, fig. 4, June 15, 1907; Bull. 309 U. S. Geol. Surv., p. 147, pl. 30, fig. 4 (same figure), 1907; Bull. 396, pl. 9, fig. 4, 1910, reprinted in Bull. 398, pl. 31, fig. 4, 1910; Temblor formation, middle Miocene of the Coalinga district and the Santa Monica Mountains.

[2] *Siratus* Jousseaume, Le Naturaliste, An. 2, p. 335, 1880, type (by original designation), *Purpura sirati* Adanson, = *Le Sirat* Adanson, Hist. Nat. du Sénégal, p. 125, pl. 8, fig. 19, 1757, = *Murex senegalensis* Gmelin, Syst. Nat., Ed. 13, p. 3537, 1790, figured by Reeve, Conch. Icon., *Murex*, pl. 24, species 101, Aug., 1845; Senegal, Recent.

Chicoreus (Murithais) wilkesanus (Anderson)

Plate 32, Figure 12

Fusus (*Hemifusus*) *wilkesona* F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 3 (Geol.), Vol. 2, p. 205, pl. 16, figs. 81, 82, December 4, 1905.

Type specimen: In the collection of the California Academy of Sciences, if not lost in the San Francisco earthquake.

Type locality: Kreyenhagen oil wells, Kings County, California, lower middle Miocene.

Miocene: Temblor formation, lower middle Miocene of Kreyenhagen oil wells, Kings County (Anderson); Superior Oil Company's well, Ansolabehere No. 1, northwest of Bakersfield, upper or possibly middle Miocene (H. R. G.).

Subgenus **PHYLLONOTUS** Swainson, 1833

Phyllonotus Swainson, Zool. Illust., Ser. 2, Vol. 3, pl. 109, 1833; Treat. Malac., p. 296, 1840; Woodring, Carnegie Inst., Publ. No. 385, p. 289, 1928.

Type (by monotypy), *Murex* (*Phyllonotus*) *imperialis* Swainson, = *M. pomum* Gmelin, figured by Tryon, Man. Conch., Ser. 1, Vol. 2, p. 97, pl. 20, fig. 182, 1880; also figured by Woodring, *op. cit.*, p. 290, pl. 17, fig. 9, 1928; Recent, West Indies, also Miocene of Bowden, Jamaica, and of Colombia, and Miocene or Pliocene of North Carolina.

Chicoreus (Phyllonotus) hippocastanum (Philippi)

Murex bicolor Valenciennes, Humboldt's Voy. Intér. Amér., Obs. Zool., Vol. 2, p. 301, 1832; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 11, fig. 44, 1845; Tryon, Man. Conch., Ser. 1, Vol. 2, p. 101, pl. 23, fig. 204, 1880; not *Murex bicolor* Risso, 1826, nor Renier, 1804.

Murex hippocastanum Philippi, Abbild. Beschreib., Vol. 1, Heft 8, p. 1, pl. 1, fig. 2, January, 1845; young specimen?

Phyllonotus bicolor Valenciennes, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 218, 1909; Nautilus, Vol. 32, p. 23, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918); upper Quaternary at San Ignacio Lagoon, Lower California, Mexico (Jordan).

Recent: Guaymas, Mexico, to Paita, Peru (Dall, 1909).

Chicoreus (Phyllonotus) princeps (Broderip)

Murex princeps Broderip, Proc. Zool. Soc. London for 1832, p. 175; Reeve, Conch. Icon., Vol. 3, *Murex*, pl. 6, fig. 23, May, 1845; Sowerby, Thes. Conch., Vol. 4, *Murex*, p. 33, pl. 19, figs. 175, 176, 1880.

Murex (*Phyllonotus*) *princeps* Broderip, Tryon, Man. Conch., Ser. 1, Vol. 2, p. 106, pl. 28, fig. 250, 1880.

Phyllonotus princeps Broderip, Dall, Nautilus, Vol. 32, p. 23, 1918.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall).

Recent: West coast of Mexico and Central America.

Chicoreus (Phyllonotus) stearnsii (Dall)

Murex (*Phyllonotus*) *stearnsii* Dall, Nautilus, Vol. 32, p. 26, July, 1918.

Type specimen: In the U. S. National Museum.

Type locality: "Fossil on Magdalena Island," Lower California, Mexico.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall).

Subgenus **MURICANTHUS** Swainson, 1840

Centronotus Swainson, Zool. Ill., Ser. 2, Vol. 3, no. 22, pl. 100, 1833, not *Centronotus* Lacepède, 1802, nor Schneider, 1801.
Muricanthus Swainson, Treat. Malac., p. 296, May, 1840, species included, *radix* Sow., Zool. Ill., Ser. 2, pl. 113, and *melanomathus*, Ency. Méth., pl. 418, fig. 2; Herrmannsen, Ind. Gen. Malac., Vol. 2, p. 69, July 17, 1847; Gray, Proc. Zool. Soc. London, p. 133, Nov., 1847.

Type (by subsequent designation, Herrmannsen and Gray, 1847), *Murex radix* Swainson.

Shell like that of *Phyllonotus* but with more numerous lamellar varices, the edges of which are raised up into many moderately short, trigonal lamellar spines; the spire low, the body whorl large, rounded.

This group, which should probably not be more than a section, is as different from *Phyllonotus* as the latter is from *Chicoreus;* but the differences are very small.

Chicoreus (Muricanthus) radix (Gmelin)

Murex radix Gmelin, Syst. Nat., Ed. 13, p. 3527, 1790; Lamarck, Hist. Anim. s. Vert., Vol. 7, p. 168, 1822; Tryon, Man. Conch., Ser. 1, Vol. 2, p. 105, pl. 27, figs. 244, 247, 248, 1880.
Phyllonotus radix Lamarck, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 219, 1909; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 151, 1924.

Pleistocene: Upper Quaternary of San Ignacio Lagoon, Lower California (Jordan), and upper Pleistocene of coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Acapulco, Mexico, southward to Panama and Paita, Peru (Dall).

Superfamily TAENIOGLOSSA

Family BURSIDAE

The *Bursidæ*, formerly called the *Ranellidæ,* differ from the *Muricidæ* in radular characters and in the less often closed anterior canal and from the *Cymatiidæ* in having a well-developed posterior canal. Dall's "Review of the Frogshells and Tritons"[1] contains information and references to early literature; but the family and related families now stand in need of revision, both in classification and nomenclature.

Genus BURSA Bolten, 1798

Bursa Bolten, Mus. Boltenianum, Pt. 2, p. 128, 1798; Jousseaume, Bull. Soc. Zool. France, Vol. 6, p. 174, 1881; Cooke, Proc. Malac. Soc. London, Vol. 12, p. 5, 1916; Woodring, Carnegie Inst., Publ. No. 385, p. 302, 1928.

Type (by subsequent designation, Jousseaume, 1881), *Bursa monitata* Bolten, = *Murex bufonius* Gmelin, figured by Tryon, Man. Conch., Ser. 1, Vol. 3, p. 39, pl. 19, fig. 11, pl. 21, figs. 21, 22, 23, 1881; Indo-Pacific, Recent.

Shell ovate, rather compact, with two continuous opposite varices or protruding nodosities; aperture ovate, with a well-marked posterior canal and an open, curved anterior canal; columella arcuated or ridged.

Bursa californica Hinds

Ranella californica Hinds, Ann. Nat. Hist., Vol. 11, p. 255, April, 1843; Zool. Voy. Sulphur, Moll., p. 12, pl. 2, figs. 4, 5, 1844; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 73, 1868-9; Keep, West Coast Shells, p. 44, fig. 24, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 287, 1903.
Ranella (Lampas) californica Hinds, Tryon, Man. Conch., Ser. 1, Vol. 3, p. 40, pl. 22, fig. 42, 1881.
Bursa (Bufonaria) californica Hinds, Dall, U. S. Nat. Mus., Bull. 112, p. 141, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 241, pl. 33, figs. 7, 8, 1927.
Bursa californica Hinds, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

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[1] Smithsonian Misc. Coll., Vol. 47, pp. 114-144, 1904.

Type locality: San Diego, California, Recent.

Pliocene: Kirker's Pass (*fide* Arnold); "Fernando" of Puente Hills, Los Angeles County (coll. by R. N. Ferguson).

Pleistocene: Upper San Pedro series in San Pedro region; Pleistocene at Pacific Beach, San Diego (Arnold); lower Quaternary of Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926).

Recent: Monterey, California, to Cedros Island, Lower California, Mexico (Dall, 1921).

Bursa ventricosa (Broderip) of the Peruvian Recent fauna is very similar in general aspect but is more ventricose, with a thinner shell, lower spire, and smoother surface.

Family CYMATIIDAE

The type of *Cymatium*[1] is a peculiar shell, with three very large varices and a long, almost closed anterior canal. The *Cymatiidæ* intergrade with the *Muricidæ* as well as with the *Bursidæ*. All of these families need revision.

Genus CABESTANA Bolten, 1798

Cabestana Bolten, Mus. Boltenianum, p. 130, 1798, *Murex cutaceus* Linnæus included; Dall, Smithsonian Misc. Coll., Vol. 47, p. 134, 1904.

Aquillus Montfort, Conchyl. Syst., Vol. 2, p. 578, 1810, type (by original designation), *Murex cutaceus* Linnæus.

Turritriton Dall, Smithsonian Misc. Coll., Vol. 47, p. 133, Aug. 6, 1904, type (by original designation), *Triton gibbosus* Broderip.

Type (by subsequent designation, Dall, 1904), *Murex cutaceus* Linnæus, Syst. Nat., Ed. 12, p. 1217, 1767; figured by Reeve, Conch. Icon., Vol. 2, *Triton*, pl. 11, species 39, May, 1844; Mediterranean.

Shell of moderate size, or small, thick for its size, with one and a half varices to a whorl (three varices to two whorls, giving the shell a trigonal appearance), whorls tabulated, with rounded nodes on the angle between the varices, minor sculpture of spiral ridges covered with small pustules; spire short, body whorl large, anterior canal short, aperture rounded, outer lip denticulated.

Cabestana is so much like *Cymatium* that it may well be and often has been considered a subgenus of *Cymatium.* However, the latter is much larger, has very large, prominent varices with high shoulders, a very elongate, expanded, trigonal aperture, and a narrow, curving anterior canal. *Turritriton,* on the other hand, is hardly of sectional value. *C. gibbosa* differs only in having a very slightly longer anterior canal and less developed siphonal fasciole. It is a variable species. One form figured by Kobelt and the figure reproduced by Tryon shows sutures sunken below the level of the tabulation. This appears to be the more characteristic form and is most common in the collections. However, another form figured by Reeve and one of the figures also reproduced by Tryon has less marked tabulations and higher sutures. The two forms, though differing in appearance, are probably conspecific. The latter shows the close relationship between this group and *Septa* Perry,[2] of which *Lampusia* Schumacher[3] is probably a synonym.

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[1] *Cymatium* Bolten, Mus. Boltenianum, p. 129, 1898, type (by subsequent designation, Dall, Smithsonian Misc. Coll., Vol. 47, p. 133, 1904) *Murex femorale* Linnæus.

[2] *Septa* Perry, Arcana, pl. 2, Jan. 1, 1810, type (by monotypy), *Septa scarlatina* Perry, pl. 2, fig. 2, also figured in Perry's Conchology, pl. 14, fig. 2, April, 1811, = *Murex rubecula* Linnæus, Syst. Nat., Ed. 10, p. 749, 1758; Matthews and Iredale, Victorian Naturalist, Vol. 29, pp. 9, 10, 1912.

[3] *Lampusia* Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 250, 1817, two sections included, the first typified by *Murex pileare* Linnæus, Chemnitz, Neues Syst. Conch. Cab., Vol. 4, p. 89, pl. 130, figs. 1242, 1243, 1248, 1249, pl. 131, figs. 1250, 1251, 1780, and Vol. 11, p. 115, pl. 191, figs. 1837, 1838, dated 1795, the second typified by *Murex tritanis* Linnæus, Chemnitz, Vol. 4, p. 112, pl. 134, figs. 1277, 1280, 1281, pl. 135, figs. 1282, 1283, 1780; Herrmannsen, Ind. Gen. Malac., Vol. 1, p. 575, May 25, 1847; Gray, Proc. Zool. Soc. London for 1847, p. 133, Nov., 1847; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 297, 1928; type (by subsequent designation, Herrmannsen and Gray, 1847), *Murex pileare* Linnæus, Syst. Nat., Ed. 10, p. 749, 1758, figured by Reeve, Conch. Icon., Vol. 2, *Tritan*, pl. 7, fig. 23, April, 1844, Philippine Islands, Recent.

Septa could be considered a subgenus with the whorls not tabulated, the spire high, and no large nodes on the angle between the varices to break the even curve of the pustulated spirals. *Gutturnium*[1] is also similar and could be considered a subgenus with the whorls not tabulated, the minor sculpture finer, the anterior canal longer and strongly bent back, and the inner lip and body whorl spread with a thick, wide deposit of callus. The inner lip of *gibbosa* is not extended and has a distinct edge. *C. exarata* (Reeve)[2] is similar to *gibbosa* in general appearance. *Gyrineum* has a small, heavy shell, with its varices arranged bilaterally and extending continuously from whorl to whorl up the spire. It is not known whether this distinction is of importance or not.

Cabestana gibbosa (Broderip)

Triton gibbosus Broderip, Proc. Zool. Soc. London, Pt. 1, p. 7, May, 1833; Reeve, Conch. Icon., Vol. 2, *Triton*, pl. 11., fig. 38, pl. 14, figs. 38*b*, 38*c*, 1844; Cooper, Calif. State Mining Bureau, Bull. No. 4, Pt. 3, p. 32, 1894.

Triton (*Gutturnium*) *gibbosus* Broderip, Tryon, Man. Conch., Ser. 1, Vol. 3, p. 23, pl. 12, figs. 101, 103, 1881.

Tritonium gibbosus Broderip, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 286, 1903.

Cymatium gibbosum Broderip, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 225, 1909; U. S. Nat. Mus., Bull. 112, p. 141, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 243, 1927.

Type specimen: In the British Museum.

Type locality: Panama, Recent.

Pleistocene: Rare in upper San Pedro series of San Pedro, Los Angeles County (Arnold).
Recent: San Pedro, California, to Panama (Dall, 1921); Panama to Guayaquil (Dall, 1909).

The varices of this species are not continuous, those on the spire being offset from those on the body whorl.

Genus GYRINEUM Link, 1807

Gyrineum Link, Beschr. Natur.-Samml. Univ. Rostock, Pt. 2, p. 123, 1807, *fide* Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 384, footnote, 1927; Dall, Smithsonian Misc. Coll., Vol. 47, p. 131, Quarterly Issue, Aug. 6, 1904.

Apollon Montfort, Conchyl. Syst., Vol. 2, p. 571, 1810, type (by original designation), *Murex gyrinus* Linnæus.

Apollo Montfort em., Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 195, 1897, type stated, *Murex gyrinus* Linnæus.

Type (by subsequent designation, Dall, 1904), *Murex gyrinus* Linnæus, figured by Tryon, Man. Conch., Ser. 1, Vol. 3, p. 43, pl. 23, fig. 48, 1881; Australia, Recent.

Shell small, ovate or oblong, with two varices, which are generally continuous and opposite; anterior canal short.

Gyrineum elsmerense English

? Triton sp., Arnold, Proc. U. S. Nat. Mus., Vol. 32, pl. 50, fig. 5, 1907.

Gyrineum elsmerense English, Univ. Calif. Publ. Geol., Vol. 8, p. 215, pl. 23, fig. 6, 1914.

Type specimen: In the collection at the University of California.

Type locality: Elsmere Canyon, Los Angeles County, Pliocene.

Pliocene: Lower Pliocene of Elsmere Canyon, Los Angeles County (English).

This species seems to be appropriately placed in *Gyrineum*, though it may be related to the Ranellas.

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[1] *Gutturnium* Klein, Ostrac., p. 51, 1753, pre-Linnæan; Herrmannsen, Ind. Gen. Malac., Vol. I, p. 492, May 25, 1847, not validated; Mörch, Cat. Yoldi, Pt. 1, p. 109, 1852, *T. tuberosum* Lamarck included; Dall, Smithsonian Misc. Coll., Vol. 47, p. 133, 1904; Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 298, 1928; type (by subsequent designation, Dall, 1904), *Triton tuberosum* Lamarck, figured as *Triton tuberosus* Lamarck by Reeve, Conch. Icon., Vol. 2, *Triton*, pl. 1, species 1, March, 1844, West Indies, Recent.

[2] *Triton exaratus* Reeve, Conch. Icon., Vol. 2, *Triton*, pl. 13, species 50, June, 1844; Australia and New Zealand.

Genus RANELLA Lamarck, 1816

Ranelle Lamarck, Extr. Cours. Zool., 1812, vernacular use only.

Ranella Lamarck, Ency. Méth., Vers, pls. 413, 414, list, p. 4, 1816; Children, Quart. Journ. Sci., Lit., and the Arts, Vol. 16, p. 49, Oct., 1823.

Not "*Ranella* Lamarck," of various authors, = *Bursa*.

Gyrina Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 253, 1817, type (by monotypy) *Gyrina maculata* = *Buccinum reticulatum* Chemnitz, Neues Syst. Conch. Cab., Vol. 4, p. 80, pl. 128, fig. 1228, 1780.

Eugyrina Dall, Smithsonian Misc. Coll., Vol. 47, p. 132, Aug. 6, 1904, type (by original designation) *Ranella gigantea* Lamarck; Cooke, Proc. Malac. Soc. London, Vol. 12, p. 3, 1916.

Type (by subsequent designation, Children, 1823), *Ranella gigantea* Lamarck, Ency. Méth., pl. 413, list, p. 4, 1816; figured by Born, Test. Mus. Cæs. Vind., p. 301, pl. 11, fig. 5, 1780 as *Murex reticularis* Linnæus and by Children, pl. 5, fig. 181, who says it is the same as *Murex reticularis* Linnæus; see also Deshayes in Lamarck, Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 9, p. 540, 1843, who also calls it *Ranella reticularis;* figured by Reeve, Conch. Icon., Vol. 2, *Ranella*, pl. 1, species 3, July, 1844; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, p. 28, pl. 3, fig. 1, 1882, say it is not *reticularis,* as Hanley identified Linnæus' type as *R. tuberculata* Broderip; Hanley says (Ipsa Linnei Conchylia, p. 287, 1855) that according to Linnæus' type specimen *Ranella gigantea* Lamarck is *Murex olearium* Linnæus; Mediterranean, Recent.

Shell large but not very heavy, with a high spire, rounded whorls, and short anterior canal; sculptured with rounded axial ribs and spiral ridges which become slightly nodular at the intersections, often with one or more of the axial ribs accentuated above the others in the form of a varix, typically with the varices well marked, two to a whorl and only slightly offset from whorl to whorl up the spire; aperture rounded, often with a moderate number of rounded denticles inside the outer lip at the varix stage, these denticles sometimes obsolete, and a prominence near the top of the inner lip; hairy epidermis usually conspicuous.

This genus might be considered a subgenus of *Gyrineum;* but it is much larger, with a relatively thinner shell, and seems to be less tropical in distribution. It has about the same shape and is connected by such species as *R. cruentata* Sowerby and *R. affinis* Broderip. Another older name that must be considered for this genus is *Monoplex* Perry.[1] If *M. australasiæ* should be properly designated as the type, *Monoplex* might not be more than subgenerically distinct from *Ranella*. *M. australasiæ*[2] is characterized by a few, rather large, square-shouldered spiral ridges, a shell that is not very heavy, with a terminal varix only, the outer lip not much thickened. Perry's other species belong to entirely different groups.

Argobuccinum should not be used as of Mörch, 1852, but of Klein in Herrmannsen, 1846, with the type *Murex argus* Linnæus by original designation. *Buffo* Montfort, 1810, not *Buffo* Lacepède, 1788, nor *Bufo* Laurenti, 1768, is a synonym. *Argobuccinum* can be used as a section of *Ranella* with short ovate shell and weak sculpture covered with a heavy epidermis.

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[1] *Monoplex* Perry, Conchology, or the Natural History of Shells, pl. 3, 1811, five species included: fig. 1, *cornutus;* fig. 2, *oboesus;* fig. 3 *australasiæ;* fig. 4, *capitotus;* fig. 5, *formosus;* all new species. So far as the writers have been able to ascertain, no one of these species has been selected as the type. Gray, Herrmannsen, Dall, and others have cited *Triton succincium* Lamarck, *Murex olearium* Linnæus, or other names of which Perry's third species may be a synonym; but as these names are not referred to by Perry, these citations cannot be accepted as fixing the type. Dall came the nearest to it when he said (Smithsonian Misc. Coll., Vol. 47, p. 138, 1904) that Gray selected *T. olearium* (L.) Reeve, = *Monoplex australosiæ* Perry, fig. 3, = *M. costatus* Born. However, Gray did not mention Perry's species and it is doubtful whether Dall's saying that he did when he didn't would constitute designation, especially as Reeve's *olearium* and *M. costatus* Born are apparently not the same as *australasiæ*. Pilsbry (Proc. Acad. Nat. Sci. Phila., Vol. 56 (for 1904), p. 22, Feb. 10, 1904) cited *cynocephalus* Lamarck, which may be the same as Perry's first species; but this citation cannot be regarded as fixing the type. This species has a rather low spire and a rather long, narrow, curving canal, but it is not so extreme as *Murex clavator*, the type of *Ranula* and *Ranularia* Schumacher, 1817. If Perry's first species should become the type of *Monoplex*, then *Gutturnium* Klein in Mörch, 1852, with *Triton tuberosum* Lamarck as the type, would probably become a synonym.

[2] Accessible figures that are really of this species are hard to find. Tryon figures it as *Triton* (*Simpulum*) *olearium* Linnæus, Man. Conch., Vol. 3, p. 11, pl. 6, fig. 37 (only), 1881. Reeve's figure, Conch. Icon., Vol. 2, pl. 10, fig. 32, May, 1844, is not of this species. *Simpulum* Klein in Mörch, 1852, might have been a name available for this group, but apparently the name had been previously employed by Fabricius, 1823.

Subgenus **RANELLA**, s. s.

Shell large, not very heavy, with rather strong, opposite varices only slightly offset up the spire, and low denticles on the inside of the outer lip.

Ranella dilleri (Anderson and Martin), according to its figure, is so much like *R. gigantea* that there appears to be no way of distinguishing it even specifically.[1] All the groups of *Ranella* are probably closely related, and the distinctions between them may be of little value. The differences between *dilleri* and *oregonensis* are not very great.

Subgenus **PRIENE** H. and A. Adams, 1858

Priene H. and A. Adams, Gen. Rec. Moll., Vol. 2, p. 654, Nov., 1858, in the addenda and errata, changing the name *Argobuccinum* Klein as used on page 104, Volume 1, to *Priene*, species included, *rude* Broderip and *scabrum* King; Cossmann, Ess. Paléo. Comp., Vol. 5, p. 109, 1903.

Type (by subsequent designation, Cossmann, 1903), *Triton scaber* King; figured by Reeve, Conch. Icon., Vol. 2, *Triton*, pl. 11, species 34, May, 1844; west coast of South America.

Shell like that of typical *Ranella*, but shorter, heavier, the varices less accentuated and less regular, the axial ribs better developed or at least more nearly continuous from the top to the bottom of each whorl.

Section PRIENE, s. s.

Shell short, rather heavy, apt to have denticles on the inside of the outer lip.

Ranella (Priene) pacifica (Dall)

Argobuccinum (Priene) pacifica Dall, Prof. Paper 59 U. S. Geol. Surv., p. 56, pl. 5, fig. 9, pl. 6, fig. 2, 1909; Howe, Univ. Calif. Publ. Geol., Vol. 14, table opposite p. 93, 1922.

U. Miocene: Coos Bay, Oregon (Dall; Howe).
? Pliocene: Purisima formation of Santa Cruz County, California (Arnold in Dall).

This form is almost exactly like *R. scabra* (King) and may even be conspecific with it. It is probable also that *corbiculata* and *coosensis* are only varieties or variations, occurring in the same deposits, and even *mediocris* may also belong in the same species. The Purisima specimens grade into *oregonensis* and are probably conspecific with *oregonensis*.

Ranella (Priene) corbiculata (Dall)

Gyrineum (mediocre var.?) corbiculatum Dall, Prof. Paper 59, U. S. Geol. Surv., p. 55, pl. 7, fig. 9, April 2, 1909.

Argobuccinum (Fusitriton) coosense Dall, Prof. Paper 59, U. S. Geol. Surv., p. 55, pl. 7, fig. 4, April 2, 1909.

Argobuccinum coosense Dall, Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 32, 1916; Howe, Univ. Calif. Publ. Geol., Vol. 14, table opposite p. 93, 1922.

Bursa trampasensis Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 492, pl. 67, fig. 3, 1915.

Gyrineum mediocre var. *corbiculatum* Dall, Weaver, Univ. Wash. Publ. Geol., Vol. 1, no. 1, p. 32, 1916.

Gyrineum corbiculatum Dall, Howe, Univ. Calif. Publ. Geol., Vol. 14, table opposite p. 93, 1922.

Type specimens: Of *corbiculata* and *coosensis*, in the U. S. National Museum, *corbiculata* No. 153,870, *coosensis* No. 153,903; of *trampasensis*, at the University of California.

Type localities: Of *corbiculata* and *coosensis*, Miocene of Coos Bay, Oregon; of *trampasensis*, lower San Pablo formation of middle California.

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[1] *Argobuccinum dilleri* Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 71, pl. 4, fig. 7, 1914; Miocene of Oregon.

U. Miocene: Empire formation of Coos Bay, Oregon (Dall); Montesano formation of Washington (Weaver); San Pablo of Las Trampas Ridge (Clark).
Pliocene: Coos Conglomerate, Coos Bay, Oregon (Howe).

The reported range and characters of *corbiculata* and *coosensis* are almost exactly the same, and *trampasensis* has similar characters.

Ranella (Priene) mediocris (Dall)

Gyrineum mediocre Dall, U. S. Geol. Surv., Prof. Paper 59, p. 54, pl. 7, fig. 6, April 2, 1909; Amer. Journ. Sci., Ser. 5, Vol. 4, p. 313, 1922; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93 and table opposite, 1922.
Ranella marshalli Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 223, pl. 6, fig. 62, 1909; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916.

Type specimens: Both in the U. S. National Museum.

Type localities: Of *mediocris*, Coos Bay, Oregon, upper Miocene: of *marshalli*, Quillayute, Washington, reworked upper Miocene deposit.

Miocene: Montesano formation of Washington (Weaver); Empire formation of Coos Bay, Oregon (Dall); Quillayute formation, redeposited Miocene fossils, near Quillayute, Washington (Reagan); Bogachiel River, Washington (Dall).
Pliocene: Coos conglomerate, Coos Bay, Oregon (Howe).

This form may be but a variety of *pacifica* or *corbiculata*, as Dall suspected, bearing a relation to the other forms like that between the type and paratypes of *lewisii*.

Ranella (Priene) lewisii (Carson)

Gyrineum lewisii Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 53, pl. 2, figs. 1, 2, 1926.

Type specimen: In the type collection at Stanford University, No. 114.

Type locality: Fugler's Point, Santa Maria district, Santa Barbara, California, Pliocene.

Pliocene: Lower Pliocene of Fugler's Point, Santa Barbara County (Carson).

Carson's type specimen is a large shell with a nearly smooth surface except for the widely-spaced, spiral, impressed lines and the opposite varices. His paratype is different in appearance, having low axial undulations, and it may be a different species. However, it is likely that this group is subject to considerable individual variation and possibly several so-called species will have to be reduced to varieties or synonyms when more abundant material can be assembled.

Carson's paratype of *lewisii* has a resemblance to *Ranella mathewsonii* (Gabb), which is an Oligocene species.

Section FUSITRITON Cossmann, 1903

Fusitriton Cossmann, Ess. Paléo. Comp., Vol. 5, p. 109, 1903.

Type (by original designation), *Triton cancellatum* Lamarck, Ency. Méth., pl. 415, fig. 1, Liste, p. 4, 1816, see Hist. Nat. Anim. s. Vert., Desh. and M. Edw. Ed., Vol. 9, p. 638, 1843; figured by Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 7, *Triton*, p. 45, pl. 16, figs. 1, 1842; also figured by Cossmann, *loc. cit.*, text fig. 8; Recent, "Amérique méridionale," ? Chile, etc.

Shell rather high spired, not very heavy, the varices weak and irregular or not accentuated at all, the denticles on the inside of the outer lip obsolete or nearly obsolete, but the prominence near the top of the inner lip well developed.

This section is very close both to typical *Ranella* and to *Priene.* If *Ranella* should be considered a subgenus of *Gyrineum* coordinate with *Monoplex* or a subgenus of *Monoplex,* then *Priene* could well be treated as a section coordinate with *Fusitriton* and *Argobuccinum.* Perhaps *Priene* should not be treated as more than a section anyway, and *Fusitriton* may not even be sectionally distinct from *Priene.*

Ranella (*Priene*) *cancellata* (Lamarck) may be the proper name for *oregonensis.* Lamarck and Kiener reported it from South America and Tryon reported it doubtfully from Chile, etc., probably on their authority; but it is well known that the older records of occurrences have frequently been erroneous. One error might account for all the reports. Most of the published figures of "*cancellatus*" have been of North American specimens, and the figures by Kiener and Cossmann show no characters by which the "South American" specimens can be distinguished. The writers have seen no recent, authentic report of such a form from South America. If Lamarck's type actually came from the northern end of the Pacific instead of the southern, as would be shown by the failure to find the species in South America after extensive collecting, then *oregonensis* would almost certainly be a synonym; and even if it is truly a South American form, it may be conspecific with *oregonensis,* having migrated across the equator, perhaps during the glacial epoch. If the writers had been able to consult Lamarck's original figure, they should probably have used the name *cancellata* for the northern shells.

Ranella (Priene) oregonensis (Redfield)

Plate 27, Figure 12

? *Triton cancellatum* Lamarck, 1816.

Triton oregonense Redfield, Ann. Lyc. Nat. Hist. New York, Vol. 4, p. 165, pl. 11, fig. 2, 1846.

Fusus oregonensis Say, Reeve, Conch. Icon., Vol. 4, *Fusus,* pl. 16, figs. 61*a*, 61*b*, 1848.

"*Fusus cancellatus* Lamarck," Reeve, Conch. Icon., Vol. 4, *Fusus,* pl. 16, fig. 62, 1848.

"*Tritonium cancellatum* Lamarck," Middendorff, Beitr. Mal. Ross., Vol. 1, Pt. 2, p. 164, pl. 3, figs. 1-4, 1849.

Tritonium (*Priene*) *oregonensis* Redfield, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 73, 1868-9; Whiteaves, Ottawa Naturalist, Vol. 7, p. 136, 1893; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 286, pl. 6, fig. 1, 1903.

"*Triton* (*Priene*) *cancellatus* Lamarck," Tryon, Man. Conch., Vol. 3, p. 34, pl. 16, figs. 164-167, pl. 17, figs. 170-172, 1881.

Priene oregonensis Redfield, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 261, 1888; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, 1916; Yokoyama, Journ. Fac. of Sci., Imper. Univ. Tokyo, Sect. 2, Vol. 1, pp. 130, 131, 1926.

Priene (*Fusitriton*) *oregonensis* Redfield, Cossmann, Ess. Paléo. Comp., Vol. 5, p. 109, pl. 5, fig. 2, 1903; Vol. 6, p. 124, pl. 9, fig. 7, 1904.

Fusitriton oregonensis Redfield, Dall, Smithsonian Misc. Coll., Vol. 47, p. 129, 1904.

Argobuccinum (*Fusitriton*) *oregonense* Redfield, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 56, 1909.

Argobuccinum oregonensis Redfield, Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 239, 1916.

Argobuccinum oregonense Redfield, Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93 and table opposite, 1922; Philpott, Publ. Puget Sound Biol. Sta., Vol. 37, pp. 369-380, pls. 34-36, 1925.

Argobuccinum (*Fusitriton*) *oregonensis* Redfield, Dall, U. S. Nat. Mus., Bull. 112, p. 141, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 15, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 242, pl. 37, figs. 1, 2, 3, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Miocene: Miocene of Coos Bay, Oregon (Howe).

Pliocene: Coos conglomerate of Fossil Point, Oregon (Dall); upper part of Wildcat series of Humboldt County (Martin); Purisima formation of middle California (Martin); Pico formation near Ventura (Waterfall); St. George Island, Pribilof group (Dall, 1919); Pliocene beds of Chichibu and Shinano; Shirado beds; Musashino; all Japan (Yokoyama); upper Pliocene of Fourth and Broadway, Los Angeles (Moody); S. D. S. N. H. locality 218, upper Pliocene of Sulphur Canyon east of South Mountain, Ventura County (H. R. G.).

Pleistocene: Common in the "Pliocene" of Deadman Island; rarer in lower San Pedro series of Deadman Island; occasionally found in upper San Pedro series of Deadman Island, San Pedro, and Crawfish George's (Arnold, 1903); lower San Pedro fauna of Nob Hill cut (T. S. Oldroyd); Santa Barbara (Cooper); southwest of Goleta, on Campbell Ranch, not common (U. S. G.); etc.

Recent: From the line of floating ice in winter in Bering Sea near the Pribilof Islands, south on the west to the Okhotsk Sea and Japan, and on the east to San Nicolas Island, California; San Diego in deeper water (Dall, 1921).

This is the well-known northern species with a coarse, hirsute epidermis and numerous low axial ribs. It usually does not have clearly developed opposite varices on the body whorl, but they are often present and sometimes very well developed on the whorls of the spire.

Ranella (**Priene**) **oregonensis** (Redfield) variety **angelensis** (Arnold)

Priene oregonensis Redfield, var. *angelensis* Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 532, pl. 50, fig. 11, 1907; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, pl. 40, fig. 11, 1907.

Type specimen: In the U. S. National Museum, No. 164,975.

Type locality: Third Street tunnel, Los Angeles, California, Pliocene.

Pliocene: Third Street tunnel, Los Angeles (Arnold); lower Pliocene of Elsmere Canyon, Los Angeles County (Eldridge and Arnold).

According to Arnold, the variety *angelensis* differs from the typical form by its longer, less recurved canal and much less pronounced sculpture. Recent specimens of the typical variety in the collections at Stanford University indicate a variation which may include Arnold's variety.

Ranella (**Priene**) **scotiaensis** (Martin)

Argobuccinum scotiaensis Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 192, pl. 21, fig. 3, August 6, 1914.

Type specimen: In the collection at the University of California.

Type locality: About ¾ mile north of Scotia, in the east bank of the Eel River, Humboldt County, Pliocene.

Pliocene: Wildcat series of Humboldt County (Martin).

This form is very close to *oregonensis* and may be better considered a doubtful variety. The allies of *oregonensis* have been overnamed.

Ranella (**Priene**) **arnoldi** (Martin)

Argobuccinum arnoldi Martin, Univ. Calif. Publ. Geol., Vol. 8, p. 192, pl. 21, figs. 4*a*, 4*b*, August 6, 1914.

Type specimen: In the collection at the University of California.

Type locality: Mouth of Bear River, Humboldt County, upper Miocene, or possibly lower Pliocene.

Miocene or *Pliocene:* Upper Miocene or lower Pliocene at the mouth of Bear River, Humboldt County, California (Martin).

This *Ranella* belongs to the *oregonensis* clan.

Ranella (Priene) cammani (Dall)

Argobuccinum (*Fusitriton*) *cammani* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 55, pl. 4, fig. 11, April 2, 1909.

Argobuccinum cammani Dall, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93 and table opposite, 1922.

Type specimen: In the U. S. National Museum, No. 153,907.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Montesano formation, upper Miocene of Washington (Weaver); Empire formation, upper Miocene of Coos Bay, Oregon (Dall).

Pliocene: Coos conglomerate, Coos Bay, Oregon (Howe).

This species is strongly constricted at the sutures. The type is a very imperfect specimen. It has narrow, distant axial ribs and spiral sculpture, and unless its appearance has been disguised by weathering it may not belong to this group.

Family CASSIDIDAE

Genus CASSIS Scopoli, 1777

Cassis Scopoli, Introd. Hist. Natur., p. 393, 1777; Montfort, Conch. Syst., Vol. 2, p. 599, 1810; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 59-61, 1909; Schenck, Univ. Calif. Publ. Geol., Vol. 16, pp. 72, 74, 1926; Woodring, Carnegie Inst., Publ. No. 385, p. 304, 1928.

Type (by subsequent designation, Montfort, 1810), *Buccinum cornutum* Linnæus, Syst. Nat., Ed. 10, p. 735, 1758.

Shell large, heavy, stout; spire very low, bearing at intervals heavy varices; aperture long, narrow, deeply emarginate at base, forming a short, strongly curved canal; siphonal fasciole high; inner and outer lips very thick; columella and adjoining part of inner lip plicate; interior of outer lip bearing heavy ridges or denticles; sculpture consisting of nodes and axial wrinkles. (After Woodring.)

Dall (1909) has given the synonymy of this genus and later Schenck (1926) discussed the genus and Pacific coast species in a paper on the Family *Cassididæ*.

The generic name *Cassis* was used by Martini in the second volume of the Conchylien Cabinet, which was apparently issued in parts, the part with *Cassis* dating from 1771, six years earlier than Scopoli. Martini used the name in the nominative singular, carefully described the shell and animal, and recognized three subgeneric groups. While there seems to be little reason to neglect the properly established names in the early volumes of the important work by Martini and Chemnitz, until some definite ruling is made in regard to which names should be used and which should be ruled out, more is gained in nomenclatorial stability by following the custom of the majority of living authors. If the genus is to be used as of Martini, the type will be *Cassis glauca* (Linnæus), designated by Children in 1823.[1] This species is included in Martini's treatment of the group.

Scopoli, who adopted *Cassis* from Klein, recognized two sub-groups, (1) "*Apertura elliptica*" and (2) "*Apertura angustiore,*" in the second of which he included "*Bucc. rufum, cornutum,* etc. Linn." The last species was selected by Lamarck in 1799 as an example of the genus *Cassis* and definitely designated genotype by Montfort in 1810.

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[1] If *Cassis* Martini is adopted, *Phalium* Link, 1807, will become an exact synonym, as it has the same type.

Subgenus **CASSIS**, s. s.

Cassis (Cassis) subtuberosa Hanna

Cassis subtuberosa Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 444, pl. 20, fig. 8, pl. 29, figs. 2, 3, March 23, 1926.
Cassis (Cassis) subtuberosa Hanna, Schenck, Univ. Calif. Publ. Geol., Vol. 16, p. 75, pl. 12, figs. 2, 3, May 4, 1926.

Type specimen: In the collection at the University of California, No. 31,275.

Type locality: Alverson Canyon, Coyote Mountain, Imperial County.

Pliocene: At the type locality (Hanna).

Subgenus **LEVENIA** Gray, 1847

Levenia Gray, Proc. Zool. Soc. London for 1847, p. 137, November, 1847; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 60, 1909.

Type (by original designation), "*Cassis coarctatum* Gray" = *Cassis coarctata* Sowerby.

The shells of this section have narrow apertures contracted in the middle, and the outer lip is not varicose.

Cassis (Levenia) coarctata Sowerby

Cassis coarctata Sowerby, Cat. Shells Tankerville, Appendix, p. xxi, 1825; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.
Cassis coarctata Wood, Index Testac., Suppl., pl. 4, fig. 5, 1828.
Cassis coarctata Gray, Reeve, Conch. Icon., Vol. 5, *Cassis*, pl. 6, fig. 14, 1848; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 272, *Cassididæ*, pl. 2, fig. 52, 1885.
Cassis (Levenia) coarctata Sowerby, Schenck, Univ. Calif. Publ. Geol., Vol. 16, p. 76, pl. 12, fig. 4, 1926.

? Pliocene: Monserrate Island, Gulf of California, Mexico, "probably Pliocene" (Hanna and Hertlein).
Pleistocene: Escondido Bay, Oaxaca, Mexico (see Schenck, 1926; in Palmer collection).
Recent: West coast of Mexico, Panama, and Galapagos Islands.

Sowerby was uncertain of the habitat of this shell, but believed it came from New Zealand. It is well figured by Reeve, and Schenck has recently figured a specimen in the Oldroyd Collection at Stanford University.

Family TONNIDAE

As the genus *Dolium* Lamarck, 1799, falls as a synonym of *Tonna* Brunnich, 1771, or in any case is of later date, the family name must become *Tonnidæ*.

Genus MALEA Valenciennes, 1832

Malea Valenciennes, in Humboldt and Bonpland, Voy. Rég. Équinox. Nouv. Cont., Recueil Obser. Zool. Anat., Comp., Vol. 2, p. 324, 1832, *fide* Woodring, 1928; Herrmannsen, Ind. Gen. Malac., Vol. 2, p. 13, 1847; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 72, 1909; Woodring, Carnegie Inst., Publ. No. 385, p. 310, 1928.

Type (by subsequent designation, Herrmannsen, 1847), *Malea latilabris* Valenciennes (= *Cassis ringens* Swainson).

Shell reaching a large size, subglobose, spire low. Nucleus naticoid, consisting of between three and four whorls, the later ones enlarging rapidly. Aperture large, wide, deeply emarginate at base, forming a wide, short canal. Siphonal fasciole inflated. Inner lip detached on adult shells at base. Columella bearing a heavy basal twist on which several folds are imposed on inner lip. Middle or parietal wall bearing two or three heavy ridges. Outer lip varicose, resorbed as growth continues, outer edge frilled, inner edge heavily ridged. Sculpture consisting of broad spiral bands. (Woodring.)

This genus lived in the Miocene and Pliocene of the Mediterranean region, was well represented in the Caribbean Miocene, and occurs in the Recent fauna of the Pacific. "*Dolium*" *jamaicense* Trechmann,[1] of the Yellow Limestone of Jamaica, middle Eocene, may be a *Malea*.[2]

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[1] Geol. Mag., Vol. 60, p. 356, pl. 18, fig. 7, 1923.

[2] *Fide* Woodring, *op. cit.*, p. 311, 1928.

Woodring (1928) designated *Buccinum perdix* Linnæus as type of both *Cadus* Bolten[1] and *Cadium* Link,[2] which makes those two names synonyms of *Tonna* Brunnich.[3] Woodring pointed out that Suter cited *Buccinum galea* Linnæus as the type of *Tonna* but that he was unable to discover who first assigned species to *Tonna* and what species, therefore, are available as type. If Suter's type designation is valid, then *Dolium* Lamarck, 1801,[4] becomes an exact synonym of *Tonna*, for they have the same type.

Malea ringens (Swainson)

Cassis ringens Swainson, Bligh Cat., Append., p. 4, 1822, reprinted in Swainson's "Exotic Conchology," Ed. 2, edited by S. Hanley.

Dolium latilabre Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 7, "Tonne," p. 14, pl. 4, fig. 6, 1835, young shell.

Dolium ringens Swainson, Reeve, Conch. Icon., Vol. 5, *Dolium*, pl. 4, fig. 5, 1848.

Malea ringens Swainson, in Sowerby, Mabille, Bull. Société Philomathique de Paris, Ser. 8, Vol. 7, p. 59, 1895.

Malea ringens Swainson, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 227, 1909; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 450, 1926.

Pliocene:[5] Coyote Mountain, Imperial County (Hanna); numerous specimens from vicinity of Alverson Canyon, Coyote Mountain (coll. by E. H. Quayle and U. S. G.).

Recent: Gulf of California, Mexico, South to Paita, Peru, and Galapagos Islands (Dall, 1909).

This species occurs rather abundantly in some localities in the Coyote Mountain region of western Imperial County, particularly in the fossiliferous beds about a half mile north of the mouth and just to the west of Alverson Canyon. In the Los Angeles Museum there is a specimen collected by Charles Sternberg at Alverson Canyon which measures 115 millimeters in axial length and nearly as much in diameter. The small Recent specimens do not show the strong ridges on the inner lip developed by mature individuals. Kiener figured a juvenile shell.

Malea camura Guppy,[6] of the lower and middle Miocene of several Caribbean localities, is a closely related but smaller and less shouldered form.

Family FICIDAE

Genus FICUS (Martini, 1777) Bolten, 1798

Ficus Klein, pre-Linnæan.

Ficus Martini, Neues Syst. Conch. Cab., Vol. 3, pp. 3, 21, etc., 1777, type (by absolute tautonymy) *Murex ficus* Linnæus (cited p. 22), this reference usually not accepted because Martini and Chemnitz, although using a binary system of nomenclature with genera (Geschlechte) and species (Gattungen), are not consistently binomial in the Linnæan sense.

Rapa Martini, *loc. cit.*, p. 21.

Ficus Bolten, Mus. Boltenianum, p. 148, 1798, type (by absolute tautonymy) *Bulla ficus* Gmelin = *Murex ficus* Linnæus; Dall, Prof. Paper 59, U. S. Geol. Survey, p. 74, 1909.

Pyrula Lamarck, "Prodr.," Mém. Soc. Hist. Nat., Paris, Ser. 1, Vol. 1, p. 73, 1799, type (by monotypy) *Bulla ficus* Linnæus; Tryon, Man. Conch., Vol. 7, pp. 258, 265, 1885; Smith, Proc. Acad. Nat. Sci. Phila., pp. 208-219, pl. 17, 1907; not *Pyrula* Reeve, Conch. Icon., Vol. 4, 1847, nor Sowerby, Thes. Conch., Vol. 4, 1880.

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[1] Mus. Boltenianum, Pt. 2, p. 150, 1798.

[2] Beschr. Natur.-Samml. Rostock, p. 113, 1807.

[3] Zoologiæ Fundamenta, p. 248, 1771, genus without species.

[4] Syst. Anim. s. Vert., p. 79, only species listed, *Buccinum galea* Linnæus. Martini (Neues Syst. Conch. Cab., Vol. 3, p. 390, 1777) used *Dolium* in a generic sense but his work is not consistently binomial. If *Dolium* should be accepted as of Martini, 1777, then the type would be "*Buccinum*" *dolium* Linnæus, by absolute tautonomy (cited as a synonym by Martini on p. 400). *Dolium* of the Museum Calonnianum (p. 19, 1797) is considered invalid and its use in the second edition of Brown's Civil and Natural History of Jamaica, 1789, is invalidated by suspension of the rules (see Opinion 89, Inter. Comm. Zool. Nomenclature).

[5] Since this paper went to press W. P. Woodring has expressed the opinion that the Coyote Mt. beds are Miocene in age (oral communication).

[6] Quart. Journ. Geol. Soc. London, Vol. 22, p. 287, pl. 17, fig. 9, 1866; also figured and discussed by Woodring, Carnegie Inst., Publ. No. 385, p. 311, pl. 20, figs. 7, 8, 1928.

Pirula Montfort, Conch. Syst., Vol. 2, p. 486, 1810, type (by original designation, etc.) *Murex ficus* Linnæus.

Ficula Swainson, Treat. Malac., pp. 85, 307, 1840, species included, *ficus*, Encyclopédie Méthodique, pl. 431, fig. 1, and *caudata* Swainson, illustrated in the Encyclopédie Méthodique, pl. 436, figs. 1*b*, 1*c*; Reeve, Conch. Icon., Vol. 4, 1 pl., 1847; Sowerby, Thes. Conch., Vol. 4, 1880.

Sycotypus Browne, Mörch, Cat. Yoldi., p. 110, 1852, species included, *ficus* Linnæus, *ficoides* Lamarck, *dussumieri* Valenciennes, and *reticulatus* Lamarck.

Pirula Lamarck emended, Cossmann, Ess. Paléo. Comp., Vol. 5, p. 140, 1903.

Type (by absolute tautonymy), *Murex ficus* Linnæus, Recent, Indian Ocean.

Shell of medium size, thin, with a very low spire or in some cases no spire; body whorl large, fig-shaped, with a broad, undefined anterior canal; axial and spiral sculpture of fine lines or cords in both directions.

Geologic range: Eocene to Recent.

Distribution: Tropical and subtemperate waters of all oceans.

Subgenus **FICUS**, s. s.

Shell very thin, outline of body whorl smoothly rounded, without angulations or nodes, anterior canal fairly long, wide, straight or nearly straight.

The species of this subgenus are few and look very much alike. It is not improbable that some of the middle Tertiary forms will be recognized as living species.

Ficus (Ficus) modesta (Conrad)

Pyrula modesta Conrad, Amer. Journ. Sci., Ser. 2, Vol. 5 (whole no. Vol. 55), p. 433, fig. 12, 1848, reprinted by Dall, Prof. Paper 59, U. S. Geol. Survey, p. 151, fig. 12, 1909.

Ficus pyriformis Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 48, 77, pl. 14, fig. 4, 1868-69; Arnold, Bull. 396, U. S. Geol. Survey, p. 18, January 15, 1910; English, Univ. Calif. Publ. Geol., Vol. 8, p. 246, pl. 25, fig. 1, 1914.

Ficus modestus Conrad, Dall, Prof. Paper 59, U. S. Geol. Survey, p. 74, 1909; English, Univ. Calif. Publ. Geol., Vol. 8, p. 246, 1914; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 372, pl. 31, fig. 2, 1926.

Shell rather elongate, spire low, rounded, sculpture of a moderate number (very roughly 25) of narrow spiral cords, with lesser intercalaries, growth lines about as strong as the finest spiral lines.

Type specimens: Of *modesta*, lost; of *pyriformis*, No. 4325, at the Academy of Natural Sciences, Philadelphia.

Type localities: Of *modesta*, Oligocene or Miocene of Oregon; of *pyriformis*, Oligocene or Miocene, near Martinez, middle California.

Oligocene: San Ramon formation, south of Martinez, Contra Costa County (type locality of *pyriformis*).

Miocene: Columbia River, near Astoria, Oregon (possibly Oligocene); Temblor formation of Coalinga region and in the Santa Cruz Quadrangle (Arnold).

The synonymy of this species was recognized by Stewart. Both Gabb and Stewart mention that it resembles the living *F. dussumieri* (Valenciennes in Kiener);[1] and it has practically the same shape as that species, though differing somewhat in the details of the sculpture. It seems to have a larger number of accentuated spirals, with fewer minor ones; but the sculpture of the living species must vary considerably, and the writers do not know whether *modesta* is really separable from *dussumieri* or even from *reticulata* (Lamarck).

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[1] *Pyrula dussumieri* Valenciennes in Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 6, *Pyrule*, p. 25, pl. 11, 1840. Living off coasts of China.

Ficus (Ficus) ventricosa (Sowerby)

Ficus tenuis magna cancellata Martini, Neues Syst. Conch. Cab., Vol. 3, p. 21, pl. 66, fig. 733, 1777.

Pyrula ventricosa Sowerby, Cat. Shells Coll. Earl of Tankerville, Appendix, p. xvi, 1825; Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 6, *Pyrule*, p. 27, pl. 12, figs. 2, 1840.

Bulla decussata Wood, Suppl. Index Test., fig. 9, 1828.

Ficula decussata Wood, Reeve, Conch. Icon., Vol. 4, *Ficula*, pl. 1, species 3, 1847; not Sowerby, Thes. Conch., Vol. 4, p. 110, pl. 423, figs. 1, 2, 3, 1880 (*fide* Tryon).

"*Ficula reticulata* Lamarck" Sowerby, *op. cit.*, p. 110, figs. 6, 7, 1880.

Pyrula decussata Wood, Tryon, Man. Conch., Vol. 7, p. 266, pl. 6, fig. 34, 1885; Mabille, Bull. Soc. Phil. Paris, Ser. 8, Vol. 7, p. 60, 1895.

Ficus decussatus Wood, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 449, pl. 21, fig. 9, 1926.

Shell not particularly elongate, spire very low, a few (10 or 12) spiral cords strongly accentuated, grading downward into more numerous, weaker spiral threads, a few minor threads in the interspaces.

Pliocene: Coyote Mt., Imperial Co., California (Hanna).
Pleistocene: Lower Quaternary of Magdalena Bay, Lower California (Jordan).
Living: Cape San Lucas, Lower California, to Ecuador.

This species is distinguished from *modesta* by its very low spire and by the accentuated spiral cords being fewer and more distant.

Subgenus **TROPHOSYCON** Cooper, 1894

Trophosycon Cooper, Bull. No. 4, Calif. St. Mining Bureau, p. 53, 1894; Dall, Prof. Paper 59, U. S. Geol. Survey, p. 75, 1909; English, Univ. Calif. Publ. Geol., Vol. 8, p. 245, 1914.

Type (by monotypy), *Agasoma ? (Trophosycon) kernianum* Cooper = *Sycotypus ocoyanus* Conrad.

Shell when young like that of a typical *Ficus;* when adult with two more or less strongly nodose angulations, an upper and a lower, and with a more or less recurved canal.

Geologic distribution: Lower Miocene to lower Pliocene in California, middle Miocene of Washington, upper Miocene of Oregon.

Cooper placed this subgenus doubtfully under *Agasoma* Gabb (as then used, *sensu lato*); Dall classed it under *Ficus;* and English considered it a separate genus, though noting that there is a "probable genetic relationship" between *Ficus* and *Trophosycon.* Since *Trophosycon* appears to be a local off-shoot clearly connected in many ways with the main *Ficus* stock, and since nodose species of *Ficus* are recorded from the European Tertiary, it is not thought desirable to obscure the relationship by calling *Trophosycon* a distinct genus.

Ficus (Trophosycon) ocoyana (Conrad)

Plate 30, Figures 3, 7, 8*a*, 8*b*, 11

Sycotypus ocoyanus Conrad, U. S. House of Representatives, Doc. No. 129, p. 19, 1855, reprinted by Dall, Prof. Paper 59, U. S. Geol. Survey, p. 170, 1909; Reports of U. S. Pacific Railroad Explorations and Surveys, Vol. 5, pt. 2, appendix, p. 329, pl. 7, figs. 72, 72*a*, Washington, 1856, reprinted by W. P. Blake, New York, 1858, (in these references the spelling of the generic name varies, probably through typographic errors); Cooper, Bull. No. 4, Calif. St. Mining Bureau, p. 54, 1894.

"Unknown" casts, Conrad, Reports of U. S. Pacific Railroad Explorations and Surveys, Vol. 5, pt. 2, appendix, pl. 7, figs. 64, 64*a*, 65, 65*a*, Washington, 1856, reprinted *with explanation of plates* by W. P. Blake, New York, 1858.

Ficus nodiferus Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pt. 2, p. 48, pt. 3, p. 77, pl. 14, fig. 5, 1868-9, *in part only;* Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 166, 175, 179, 1912; Vol. 9, p. 160 only, 1919; not *Pyrula nodifera* Binkhorst, Mon. Gast. Ceph. Craie Sup. Limbourg, p. 67, pl. 5*a*-3, fig. 11, 1861.

Ficus ocoyanus Conrad, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pt. 3, p. 113, 1868-9; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 175, 1912.

Ficula nodifera Gabb, Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 240, 1888.

Ficula ocoyana Conrad, Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 240, 1888.

Agasoma ? (Trophosycon) kernianum Cooper, Bull. No. 4, Calif. St. Mining Bureau, p. 53, pl. 3, fig. 52, 1894.

Agasoma kernianum Cooper, F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 2, pp. 176, 185, 188, 1905; Arnold, Prof. Paper 47, U. S. Geol. Survey, pp. 19, 73, 78, 83, 84, 1906; Eldridge and Arnold, Bull. 309, U. S. Geol. Survey, p. 147 questionably identified, 1907; Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 353, pl. 34, fig. 2, August, 1908; F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 3, pp. 19, 23, 25, October, 1908; Branner, Newsom, and Arnold, Folio 163 (Santa Cruz), U. S. Geol. Survey, p. 4, pl. 2, fig. 40, 1909; Arnold, Bull. 396, U. S. Geol. Survey, p. 18, January 15, 1910; Arnold and R. Anderson, Bull. 398, pp. 85, 86, 1910; F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 100, 101, 1911; McLaughlin and Waring, Folio accompanying Bull. No. 69, Calif. St. Mining Bureau, pl. 1, fig. 30, 1914.

Agasoma stanfordensis Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 384 in part, not the San Diego specimen, pl. 35, fig. 5, 1908; Branner, Newsom, and Arnold, Folio 163 (Santa Cruz), U. S. Geol. Survey, p. 4, pl. 2, fig. 54, (same figure), 1909.

Ficus kernianus Cooper, Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 166, 175, 179, April, 1912; Martin, Univ. Calif. Publ. Geol., Vol. 7, p. 148, December, 1912; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 586, 1913; Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 43, 1914; Smith, Vol. 9, p. 160, 1919.

Ficus stanfordensis Arnold, Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 166, 175, 179, 1912; Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 588, 1913; Trask, Univ. Calif. Publ. Geol., Vol. 13, pp. 141, 143, 144, 145, 1922.

Trophosycon kernianum Cooper, English, Univ. Calif. Publ. Geol., Vol. 8, p. 248, pl. 24, figs. 4, 5, 6, 1914; Hertlein and Crickmay, Proc. Amer. Phil. Soc., Vol. 64, p. 260, 1925.

Trophosycon stanfordense (Arnold), English, Univ. Calif. Publ. Geol., Vol. 8, p. 249, pl. 24, figs. 2, 3, 1914.

? "*Ficus oregonensis* Conrad," Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 30, 1916, not of Conrad (see next reference).

"*Ficus (Trophosycon) oregonensis* (Conrad)," Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, pp. 373-5 in part, (pl. 31, figs. 8, 8*a* ?), 1926, not "*Ficus (Trophosycon)*" *oregonensis* Conrad, Dall, Prof. Paper 59, U. S. Geol. Survey, p. 75, 1909, nor "*Trophosycon*" *oregonense* (Conrad), English, Univ. Calif. Publ. Geol., Vol. 8, p. 250, 1914, the last two of which refer to *Fusus oregonensis* Conrad, Amer. Journ. Sci., Ser. 2, Vol. 5, p. 432, fig. 13, 1848, reprinted by Dall, *op. cit.*, p. 150, fig. 13, 1909, which may be an *Agasoma* (*sensu lato*) but is certainly not a *Ficus*.

A *Trophosycon* of comparatively small or moderate size, shell of medium thickness, spire low, apical angle varying from about 105° to 115°; whorls five, body whorl large, angulated along two spiral rows of nodes, the upper row about one-fifth of the way from the suture to the anterior extremity as measured around the whorl, the lower about half way, shell wall between the nodes smoothly rounded and only a little more strongly curved, eight or nine nodes to a whorl on each angulation, the lower row usually alternating with the upper, nodes characteristically single and rounded like the end of a twig which has been broken off not far from the branch, but occasionally with a lesser auxiliary node on the next main spiral line above or below, the two points coalescing vertically and forming a double-headed elongate node, also very rarely a third small knob on the other side of the main node from the second; body whorl also sculptured with distinct but usually fine, low, rounded, spiral cords, of the heaviest of which there are about eight below the lower angle, one on each of the angles, three between the angles and four above the upper angle, also between each of the main spirals a smaller intercalary, which sometimes, however, becomes almost as prominent as the primaries, and between each primary and the secondary next to it a still fainter tertiary, the whole surface covered with somewhat irregular growth lines, usually about equal in strength to the spiral sculpture; anterior canal moderately long, broad, smoothly but decidedly recurved, columella smooth, curving in strongly below the lower angle and then out again, inner lip covered with a fairly thick deposit of callus which rounds over the lower row of nodes and spreads out over the upper angle of the preceding whorl, remaining exposed there in an irregular spiral strip above the suture; sutures tangential at the upper angle of the preceding whorl, or abutting slightly below it.

Dimensions (from English): Altitude 62 mm.; diameter of body whorl 45 mm.; length of aperture 54 mm., width of aperture 23 mm.; width of canal 15 mm., depth 5 mm., length about 15 mm.

Type specimens: Of *ocoyana*, drawn in the field and subsequently lost; of *nodifera*, No. 27,824 in the Whitney Collection at the Museum of Comparative Zoology, Harvard University; of *kerniana*, whereabouts unknown; of *stanfordensis*, No. 425 at Stanford University.

Type localities: Of *ocoyana*, Miocene of Ocoya (= Poso) Creek, near Barker's Ranch, Kern Co.; of *nodifera*, Miocene at Griswold's, between San Juan and New

Idria, Monterey Co. (*fide* Stewart); of *kerniana*, Miocene of Barker's Ranch; of *stanfordensis*, two and one-half miles south of Mayfield, Santa Clara Co.

Miocene: Monterey-Temblor, middle Miocene, of California, Oregon, and Washington.

Young specimens are more like typical *Ficus*, with smaller nodes or even no nodes, straighter, more elongate canal, and sculpture of sharp cords running in both directions.

Casts are impossible to distinguish from casts of small specimens of the Pliocene variety *ruginodosa*. The nodes are represented by low bumps of varying prominence along the angulations, usually more or less rounded, but sometimes vertically elongate. The outlines show the strong incurving of the columella, and, where the nodes do not interfere, the nearly vertical section of the wall between the two angles. On casts of very young specimens the nodes do not show through at all, as in Conrad's type.

The type of *Agasoma stanfordensis* Arnold has been found among the fossils stored at Stanford University and is now No. 425 in the type collection. It is a very poor cast, showing nothing but the general shape, the somewhat worn nodose impressions along the upper angle, and faint undulations on the lower. The nodes are small, and those on the side which Arnold figures have an unnatural, pinched, elongate appearance; but the shape of the nodes on the other side of the specimen is more normal and indicates that the weathered aspect is misleading. The lower part of the columella, the anterior canal, and the outer lip are missing. There is nothing on the type specimen by which it can be distinguished from the common species generally known as *Ficus kerniana* Cooper (= *Ficus ocoyana*), or, indeed, from the Pliocene forms usually known as *Ficus nodifera* Gabb. Arnold must have based his distinction from *Agasoma kernianum* largely on the characters of a specimen from the Pliocene of San Diego, upon which some of the external sculpture appears to have been preserved, for he speaks of the "usually much larger size" and the "details of the spiral sculpture . . . coarser." The San Diego specimen is not as Arnold supposed the same variety, but belongs to a form of the new variety *ruginodosa*. Since the type, the only known specimen from the type locality "two and one-half miles south of Mayfield," Santa Cruz Quadrangle, was so poorly preserved, Mr. Lionel Wiedey and the writers revisited the type locality to look for more material. Another fragmentary cast was obtained, and although it is even more poorly preserved than the type, it shows a slightly lower spire and more gently rounded nodes on the upper angulation, which is characteristic of another common variation of *ocoyana* and strengthens the conclusion that *Ficus stanfordensis* is an indistinguishable synonym. The other species collected with *Ficus stanfordensis* at its type locality include *Agasoma* (*Bruclarkia*) sp., *Pecten andersoni* Arnold, and *Arca* cf. *montereyana* Osmont, which indicate that the beds which Arnold considered upper Miocene in this locality are of Monterey-Temblor age; or, in other words, of the same horizon as that from which the type and many other specimens of *Ficus kerniana* came, and also, according to Stewart, the type of *Ficus nodifera* (Gabb). It may be worth mentioning that in Smith's paper on the Miocene fossils of California (1912) *stanfordensis* has the same distribution as both *nodifera* and *kerniana*. A more nearly complete cast in the Stanford collection from the Santa Cruz Quadrangle labeled *stanfordensis* is of typical *kerniana* (= *ocoyana*) shape. There is, therefore, unless important new evidence of a contrary nature is brought to light, no reason whatsoever for retaining the name *stanfordensis*, which has always represented among paleontologists a troublesome unknown quantity.

The cast of a very small specimen from the Miocene of Ocoya (= Poso) Creek that was named from Blake's drawings by Conrad *Sycotypus ocoyanus*, although showing very little that is of value for the identification of other specimens, has at least the low spire and general form of *Ficus*, and the two strong angulations and incurved columella of the subgenus *Trophosycon*. F. M. Anderson, who has carefully studied the Poso Creek section, states that Blake's collecting locality was almost surely on Pyramid Hill at a horizon which Anderson terms Zone A. Barker's Ranch, the type locality of *Ficus kerniana* (Cooper), is not far distant but is at a slightly higher horizon, Zone B. Good specimens of *kerniana* are, however, common at both localities, and the "unknown" casts from Blake's locality figured but not named by Conrad in the same publication have been recognized as *kerniana* by English. Moreover, young specimens of *kerniana* from Pyramid Hill, as well as some adult casts including a specimen from Griswold's in the collection at Stanford University, show a strong resemblance to the rather peculiar shape of Blake's drawing. Since *Ficus stanfordensis* has been shown to be a synonym, and since there is no reason to believe that the Miocene specimens assigned by various authors to *Ficus nodifera* are distinct, there are no other species of *Trophosycon* known from these localities, and Conrad's species, which has long been unidentifiable, can be no other than what has generally been known as *Ficus kerniana*. The only other species thought to occur in the lower or middle Miocene of the Pacific coast is *Ficus clallamensis* Weaver, a Washington species from the Clallam formation, "upper middle Miocene," which is also found in the Santa Margarita formation, upper Miocene, of California, and is questionably identified from the middle Miocene of Orange County, California. Blake's original specimen of *ocoyana* could hardly have been *clallamensis*, for no adult specimen like *clallamensis* has ever been reported from that locality, and the whorls in Blake's drawings are not broad enough above the upper angle. Nor could it be *Ficus clallamensis* variety *nodibulbosa*, which comes from the upper Miocene of California, because of the strongly incurved columella shown in Blake's drawing. It is unfortunate to have to discard so well known and well characterized a name as *kerniana*, but it is the writers' belief that it will be less difficult to do so now than later.

The identifications of *Fusus oregonensis* Conrad as a *Ficus* by Dall and Stewart were based on the supposition that Conrad's figure and description were very poor; but more recent collections from Conrad's locality include specimens of a species entirely different from the Trophosycons, and these specimens agree very closely with Conrad's illustration and description. Therefore, the middle Miocene *Trophosycon* cannot take the name of *oregonensis* Conrad.

Variety **ocoyana**, s. s.

Shell relatively small, showing adult characters when less than 40 mm. in altitude, sculpture fine, nodes usually single and rounded.

Ficus (Trophosycon) ocoyana (Conrad) variety **ruginodosa**, new variety

Plate 29, Figures 2*a*, 2*b*; Plate 30, Figures 5, 10*a*, 10*b*

Ficus nodiferus Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 48, 77, pl. 14, fig. 5, 1868-9, *in part only*, not the type; Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 203, 1916; Vol. 10, pp. 212, 213, 221, 1917; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, p. 153 only, 1919; not Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, pp. 166, 175, 179, 1912; not *Pyrula* (= *Ficus*) *nodifera* Binkhorst, Mon. Gast. Ceph. Craie Sup. Limbourg, p. 67, pl. V*a*. 3, fig. 11, 1861.

Agasoma stanfordensis Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 384, in part (not the type), 1908.

Trophosycon nodiferum (Gabb), English, Univ. Calif. Publ. Geol., Vol. 8, pp. 211, 247, pl. 25, figs. 2, 4, 1914; Kew, Bull. 753, U. S. Geol. Survey, p. 78, 1924.

"*Ficus* (*Trophosycon*) *oregonensis* Conrad," Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, pp. 373-5 in part, (pl. 31, figs. 8, 8*a* ?), 1926, not of Conrad (see synonymy under *Ficus ocoyana*).

Ficus "nodifer" (Gabb), Stewart, *op. cit.*, p. 374, in part, emended name for *Ficus nodiferus* Gabb. (Since Gabb originally used the name as *nodiferus*, it does not seem advisable to change the masculine form to "*nodifer*," even though the nominative singular masculine of the adjective which means "bearing nodes" lack the termination. We cannot be sure that Gabb did not mean *nodi* + *ferus* or "wild with nodes." The new species name, *ruginodosa* is compounded with a different adjective in order to avoid the recurrence of this question in case the species should be assigned to a masculine genus.)

A *Trophosycon* of very large size, shell of medium thickness, spire low, apical angle varying from about 105° to 115° (but if the body whorl is included in the measurement, the angle becomes considerably larger,—that is, the compound surface formed by the upper parts of all the whorls becomes concave in adult specimens); whorls five, body whorl large, angulated along two usually compound spiral rows of nodes, the upper row lying between a quarter and a fifth of the distance from the suture to the anterior extremity as measured around the whorl, the lower about half way, the shell wall between the nodes strongly curved around an angle of about 110° at the upper shoulder, and 140° at the lower; nine or ten nodes to a whorl on each angulation, the smaller number on smaller specimens; additional sculpture on the body whorl similar in pattern to that on typical *Ficus ocoyana*, but much coarser, consisting of primary, secondary, tertiary, and also quaternary cords, all but the primaries arising by intercalation between the earlier lines of sculpture, the number of primaries above the upper and below the lower angulations being, however, difficult to count because of the complication of the pattern and because all of the primaries are no longer regularly emphasized, only the three nearest to each angle standing out clearly above the others, these three being sometimes tremendously accentuated, bunching up periodically on large specimens into triple nodes, growth lines present but weak in comparison; anterior canal moderately long, broad, smoothly but decidedly recurved in the adult, columella smooth, in mature specimens curving in strongly below the lower angle and then twisting out again and over, inner lip covered with a fairly thick deposit of callus, which partially rounds over the lower row of nodes and which spreads out over the upper angle of the preceding whorl and remains exposed there in an irregular spiral strip above the suture, outer lip simple, tangential at the upper angle or abutting slightly below it.

Dimensions of type: Altitude 110 mm.; diameter of body whorl 80 mm.; height of spire above body whorl 17 mm.; long axis of aperture (exclusive of canal) 70 mm.; length of canal (estimated) 30 mm.; width of canal 20 mm., depth 8 mm.

Type specimen: No. 3 in the type collection of the San Diego Society of Natural History.

Type locality: No. 209 S. D. S. N. H., basal Pliocene of Elsmere Canyon, Los Angeles County.

Lower Pliocene: Elsmere Canyon.
? Middle Pliocene: San Diego.

Young specimens are very different in shape, having a columella which is in most cases nearly as straight as that of *Ficus clallamensis* variety *nodibulbosa*, usually bearing little resemblance to specimens of typical *Ficus ocoyana* of the same size. One specimen in the Stanford collection from Elsmere Canyon has preserved its youthful characters up to a size of 70 mm., but this is probably unusual. Young specimens are more elongate; but care must be taken in judging the relative proportions of any specimens which have defective body whorls, for they always give an erroneous appearance of being unusually elongate, as is shown by the shell-covered part of the type of the variety *contignata*, if one imagines the other part removed.

The question of nomenclature arises here again. The preoccupation of the name *nodifera* by Binkhorst, whose work was published eight years earlier than Gabb's, means that the form from Elsmere Canyon, even if properly identified as Gabb's *nodifera*, probably requires a new name. Stewart, however, has inferred from the matrix of Gabb's type (the specimen which he figures,—*loc. cit.*) that it is the specimen mentioned by Gabb as coming from the Miocene of Griswold's, in which case the Pliocene form has never received a name. The soundness of this inference is questioned: because Gabb states that "the best preserved specimen yet obtained was found by Mr. Frank E. Brown in the rich fossiliferous Pliocene sandstones of the San Fernando Pass, at the west end of San Gabriel Mountains," and it is to be supposed that Gabb would use the best specimen for his description and illustration; also because the type figured by Stewart retains a large part of the shell, as is commonly the rule with Elsmere Canyon specimens, whereas the other specimen mentioned by Stewart as part of the type material is a cast like the only specimen of *Ficus* from Griswold's that the writers have seen; because there are several kinds of matrix to be found in the fossiliferous beds of Elsmere Canyon; and because Stewart's figure of the type, although not characteristic, looks more like an Elsmere Canyon specimen than one from the Miocene. It is fortunate that the preoccupation of the name will eliminate the necessity of deciding this question. The point is discussed here merely because Stewart's figure, if its assignment to the Miocene were not questioned, might cause difficulty in distinguishing the varieties. To avoid this point, the form *ruginodosa* is described as entirely new, not as a new name for *nodifera* Gabb.

The variety *ruginodosa* has when young, or when about the average size of *Ficus ocoyana*, very rudimentary nodes, nodes which are usually smaller than on the latter species and are so inconspicuous that some specimens have been mistaken for a typical *Ficus*. At that stage, the vertical striations are about equal in strength to the secondary spirals. The nodes on the upper angulation are usually single, being a little stronger and appearing a little earlier than the nodes on the lower angulations, which are usually triple and develop at first merely as disconnected flexuous accentuations of the three heavy primary spirals. The lower angulation is hardly recognizable as such until the shell grows larger than most full-grown specimens of *ocoyana*. The adult is only moderately nodose for its size, but the spirals are strongly rugose; hence the name *ruginodosa*, given to stress the rugosity and to recall Gabb's name.

The variety *ruginodosa* can be distinguished from typical *ocoyana* when adult by its much larger size, by the three strong rugose spirals and the three rows of small nodes on the lower angle, and by the generally much more rugose nature of the spiral sculpture. Specimens of *ocoyana* from Barker's Ranch which are not half the size of the type of *ruginodosa* show gerontic characters such as extreme irregularity of growth lines and almost complete loss of nodes on the last part of the body whorl, indicating that the difference in size is a useful means of separating the Pliocene from the Barker's Ranch variety. The young of *ruginodosa*, moreover, are quite different from the adult of typical *ocoyana* to which they compare in size; and their characters suggest that *ruginodosa* may be derived from *Ficus clallamensis* variety *nodibulbosa* instead of from *Ficus ocoyana*, and that the similarity in shape of the adult of *ruginodosa* to the adult of *ocoyana* might be due to parallel development. The adult of *ruginodosa* is distinguishable from *nodibulbosa* by its stronger nodes and angulations and its more differentiated spiral sculpture; the young by more delicate and more distinctly differentiated spiral striation, relatively stronger vertical cords, and usually less elongate upper nodes. The typical *Ficus clallamensis* is difficult to distinguish, because nothing certain is known of the shell. It has a low spire, broad upper surface, more rounded angles, a greater ratio of diameter of body whorl to altitude, and if the Orange County specimen mentioned above as possibly a *clallamensis* can be trusted, a less complicated pattern of spiral sculpture. The very young of *ruginodosa* are distinguished only by their incipient nodes from *Ficus modesta* (Conrad), a typical *Ficus*.

The variety *ruginodosa* is definitely known only from the lower Pico (lower Pliocene) of Elsmere Canyon, Los Angeles County, California. The type came from the center of a large concretion at S. D. S. N. H. locality 309. This variety is less common than the variety *contignata*.

Ficus (Trophosycon) ocoyana (Conrad) variety **contignata,** new variety

Plate 29, Figures 1*a*, 1*b*; Plate 30, Figures 1, 2, 4, 9*a*, 9*b*

Dimensions of the type: altitude 92 mm. (canal defective, probably more than 10 mm. broken off); diameter of body whorl 83 mm.; height of spire 12 mm.

Type specimen: No. 4 in the type collection of the San Diego Society of Natural History.

Type locality: No. 203 S. D. S. N. H., Elsmere Canyon, Los Angeles Co.

L. Pliocene: Elsmere Canyon localities, also loc. 227, south of Humphreys Station; Jacalitos formation, middle California (Nomland, and in the Stanford collection).

L. or *M. Pliocene:* Basal Pliocene at San Diego (possibly should be assigned to the variety *ruginodosa*); loc. 201, upper horizon at Elsmere Canyon, one poor specimen, questionably identified (H. R. G.).

The variety *contignata* is characterized at all stages of growth after it is above 10 mm. in altitude by strongly accentuated nodosity. The nodes on both the upper and lower angles are usually triple, becoming so on some specimens at a very early stage. They stand out like tridents, projecting more than 10 mm. on the body whorl of the type. In a few specimens only, and these specimens appear to be old but stunted forms showing the mature characteristics of strong angulations and recurved canal even on a small shell, the nodes have doubled but have gone no further. Even in these cases, however, the double nodes are much stronger than is normal on typical *ocoyana.* On casts the lower nodes are represented by connected vertical ridges, and on young specimens those ridges are almost knife edges. The type of *contignata,* which is of nearly the same size as the type of *ruginodosa,* is very strongly nodose, so that the whole surface of the body whorl above the upper angulation is thrown into radiating ridges, which bear such a strong resemblance to the radiating rafters on the unfinished roof of a circular pavilion (the projecting nodes playing the role of eave supports) that the variety is named *contignata,* "raftered." All of the specimens do not show the raftered effect on the upper part of the body whorl, and a few have single nodes on the upper angulation as on *ruginodosa;* but all have strongly projecting nodes, and the intergradations with the less strongly nodular *ruginodosa* do not appear to be common. The type of this variety is an extreme form, but it is of interest, for the excesses of its nodosity indicate the senile condition of the *Trophosycon* race in the lower Pliocene.

The variety *contignata* can be distinguished by its strong nodosity from all other forms of *Trophosycon;* and its size when adult or its shape when young usually provide an additional means of distinguishing it from typical *ocoyana.* Sometimes, however, young specimens of *contignata* bear a closer resemblance to *ocoyana* than to *nodibulbosa,* and it is barely possible that this variety has a different history from that of *ruginodosa,* in which case the latter should be referred to *clallamensis* or should be considered a distinct species.

The variety *contignata* is common in the lower Pico (lower Pliocene) of Elsmere Canyon. The type is from the third fossiliferous stratum, about twenty feet above the contact with the metamorphic rocks on the north side of the main branch of Elsmere Canyon. This variety is also known from S. D. S. N. H. locality 227, south of Humphreys Station, between Soledad and Placerita canyons, Los Angeles County, lower Pico; and from the Jacalitos (lower Etchegoin), lower Pliocene of middle California. Probably also the San Diego Pliocene specimen described by Arnold as *Agasoma stanfordensis,* and possibly the type of *Ficus nodifera* Gabb not Binkhorst, figured by Stewart as *Ficus oregonensis,* belong here.

Ficus (Trophosycon) clallamensis Weaver

Ficus clallamensis Weaver, Bull. No. 15, Washington State Geol. Survey, p. 74, pl. 9, fig. 73, 1912; Univ. Wash. Publ. Geol., Vol. 1, p. 30, 1916; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, p. 157, 1919.
Trophosycon clollamense (Weaver), English, Univ. Calif. Publ. Geol., Vol. 8, p. 250, 1914.

This species, originally described from the Clallam formation of Washington, the supposed equivalent of the Temblor formation of California, is more like a typical *Ficus* than is *ocoyana*. It has a low spire with a broad, slightly convex, gently sloping area above the upper angulation. The upper angle is smoothly curved, with small nodes which reflect through only as low, broader undulations and are not visible on the figure of the type specimen but are mentioned by Weaver in his description. They are present also on the California specimens and on specimens collected by Miss N. M. Tegland in Washington. The lower angulation is indistinct and the nodes are very small, not showing at all on the cast. Weaver's specimen is large, comparable in size to *Ficus ocoyana* variety *ruginodosa*, but is different in shape and in the size of its nodes. A specimen from the Santa Margarita formation, upper Miocene of the northern portion of the Nipomo Quadrangle, San Luis Obispo County, California, is almost exactly like Weaver's type, as nearly as can be told from his figure and description. A specimen from the Temblor horizon in Orange County, California, here referred questionably to this species fits the description and the outline of the figure of *Ficus clallamensis*, except that it is not so large. The type of *clallamensis* is about 75 mm. in diameter, whereas the Orange County specimen measures only 50 mm., the altitudes not being comparable because the columellas are broken off in different places. On the Orange County specimen part of the shell and surface sculpture is preserved, the sculpture being not unlike that of *Ficus ocoyana* except that the minor spirals between the primaries are weaker, leaving the distant primaries to stand out more regularly and more prominently. Weaver mentions distant spirals as showing on the cast, (probably these markings are due to the impressions of the mould of the outer surface made after the shell had been dissolved out, for the inner surface of the shell of *Trophosycon* is usually not striated).

There is in the Stanford collection from the type locality of *Ficus clallamensis*, or near it, a large complete cast 80 mm. in altitude and marked like that species but of the shape of *Ficus ocoyana* variety *ruginodosa*. It is possible that both of these large northern specimens (Weaver's type and the Stanford specimen) and also the large upper Miocene specimen from California are but variations in form of the same species, which is not yet clearly distinguishable from the various southern forms of other horizons only because no specimens upon which the shell is preserved have been available for comparison. In that case, the Orange County specimen may be but a variation of *Ficus ocoyana* analogous to the typical variation of *clallamensis*, and the large specimen from Washington with the *ocoyana* or *ruginodosa* shape may belong to one of those forms or may be the Clallam representative of their lineage intermediate between them. The material in hand, however, is not sufficient for an investigation of these possibilities.

Another cast in the Stanford collection from the same locality (Clallam Light House, Straits of Fuca) has a low spire, a distorted shape with a broad canal, and irregular growth lines, with very inconspicuous nodes on the upper angulation and apparently no lower angulation. It has, however, the size and the faint spiral markings of the other specimen, of which it is probably but a variation. It is very similar to *Ficus rodeoensis* English,[1] which was described as a typical *Ficus* but which may be but the distorted variation of *Ficus clallamensis* or an earlier name for the variety *nodibulbosa*.

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[1] Univ. Calif. Publ. Geol., Vol. 8, p. 246, pl. 24, fig. 1, 1914.

Ficus (Trophosycon) clallamensis Weaver variety **nodibulbosa,** new variety

Plate 30, Figures 6*a*, 6*b*

? *Ficus* sp. indet., *Ficus* cf. *stanfordensis* Arnold, etc., Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 408, 422, 1915.

? *Ficus* cf. *nodiferous* Gabb, Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 301, 1917.

? "*Ficus nodiferus* Gabb," Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, p. 158 only, 1919.

A *Trophosycon* of rather large size, shell of medium thickness, spire moderately low, apical angle about 105°, or if the body whorl is included in the measurement, 110°; whorls five, body whorl fairly large, its outline marked by two rounded shoulders bearing rows of rather inconspicuous nodes, the upper shoulder with an angle of about 125°, one-sixth of the distance from the suture to the anterior extremity as measured around the whorl, the lower shoulder with a very large and inconspicuous angle, about three-fifths of the way down, nodes about nine to a whorl on each shoulder, irregularly spaced, only about a quarter as wide as the interspaces, vertically elongate, with two cusps on those of the upper shoulder and two or three on those of the lower, the lower nodes apparently sometimes directly beneath the upper, inconspicuous and probably largely superficial, both rows showing but faintly on the east and the lower not likely to show at all; spiral sculpture coarse and nearly all of the same strength, the primary and secondary series of ridges about equal in size, the tertiary scarcely ever visible, the total number of conspicuous spirals being about equal to the number of primary and secondary spirals on *F. ocoyana;* growth lines inconspicuous; anterior canal moderately long, broad, shallow, nearly straight, columella smooth, hardly curving at all below the lower angle; outer lip tangential at the upper shoulder of the preceding whorl or abutting slightly below it.

Dimensions of type: Altitude 85 mm. (canal defective, probably about 7 or 8 mm. broken off); diameter of body whorl 60 mm.; height of spire 13 mm.

Type specimen: No. 2977, at the California Academy of Sciences.

Type locality: Santa Margarita formation, upper Miocene, of middle California.

U. Miocene: At the type locality.

This form is distinguishable from the adults of all other Trophosycons by its nearly straight columella; also from *ocoyana* and its varieties *ruginodosa* and *contignata* by its weak, thin nodes and rounded shoulders; from typical *ocoyana* by its size; from typical *clallamensis* and most of the others by the comparatively narrow slope on the body whorl above the upper shoulder and by its coarser, closer spirals; and from young specimens of *ruginodosa* by its coarser, scarcely differentiated spiral sculpture, by its weaker vertical cords, and by the fact that it retains its other peculiar characters when larger.

The type was collected by F. M. Anderson from the Santa Margarita formation, upper Miocene, on the east side of section 25, T. 21 S., R. 14 E., Mt. Diablo B. & M., Fresno County, California.

It is quite possible that *Ficus rodeoensis* English, referred to above, is an earlier name for this form, but the type specimen is such a poorly preserved, distorted individual and has such a different shape that the writers have hesitated to identify it until more material is found. *Ficus rodeoensis* has a very low spire with almost conical-sided whorls, entirely lacking a lower angulation, and showing no spiral sculpture. It is, however, of large size, probably a *Trophosycon;* and occurring in approximately the same horizon, it may be either this variety or typical *clallamensis*.

Family CYPRAEIDAE

Genus CYPRAEA Linnæus, 1758

Cypræa Linnæus, Syst. Nat., Ed. 10, p. 718, 1758; Montfort, Syst., Vol. 2, p. 631, 1810.

Type (by subsequent designation, Montfort, 1810), *Cypræa tigris* Linnæus, figured by Tryon, Man. Conch., Ser. 1, Vol. 7, p. 180, pl. 11, figs. 49, 50, pl. 15, fig. 8, 1885, Indo-Pacific, Recent.

Shell convolute, spire concealed by last whorl, which is very large, smooth or enameled, rarely postulose or nodulous; aperture long, narrow, lips thickened and both denticulate.

Cypræa spadicea Swainson

Plate 27, Figure 13

Cypræa spadicea Swainson, Tillock's Philos. Mag., Vol. 61, p. 376, 1823; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 182, pl. 13, fig. 78, 1885; Dall, U. S. Nat. Mus., Bull. 112, p. 140, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 237, 1927.

Luponia spadicea Gray, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 657, 1864; Keep, West Coast Shells, p. 59, fig. 43, 1888, 1892.

Luponia spadicea Swainson, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 78, 1868-9; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 247, 1888.

Cypræa spadicea Gray, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 288, 1903.

Pliocene: S. D. S. N. H. locality 217*a*, middle Pliocene of Holser Canyon, Los Angeles County, one specimen (H. R. G.).

Pleistocene: Santa Barbara Island (Cooper); upper San Pedro series of Deadman Island and of the lumber yard at San Pedro, Los Angeles County, one specimen at each locality (Arnold).

Recent: Santa Barbara, California, to Cedros Island, Lower California, Mexico (Dall).

This species can be distinguished from *C. annettæ* Dall of southern waters by its narrower aperture, less curving inner lip, and more numerous teeth. *C. annettæ* has 19 teeth on the outer lip and 15 on the inner, while *spadicea* has 20 to 22 on the outer and 17 on the inner lip.

Cypræa fernandoensis Arnold

Cypræa fernandoensis Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 538, pl. 50, figs. 8, 8*a*, 1907; U. S. Geol. Surv., Bull. 309, pl. 40, figs. 8, 8*a*, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914.

Type specimen: In the U. S. National Museum, No. 164961.

Type locality: In Elsmere Canyon, 2½ miles southeast of Newhall, Los Angeles County, lower Pliocene.

Pliocene: Lower Pliocene of Elsmere Canyon, Los Angeles County (Arnold; English).

This form is probably an ancestral variety of *spadicea*.

Cypræa annettæ Dall

Cypræa sowerbyi Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 1, *Porcelaine*, p. 38, pl. 7, fig. 5, 1845; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 185, pl. 15, fig. 9, 1885, not of Anton, 1839, nor Gray, 1832.

Cypræa ferruginosa Kiener, *op. cit.*, p. 37, pl. 56, fig. 3, 1845, not of Gmelin, 1791.

Cypræa annettæ Dall, Nautilus, Vol. 22, p. 125, April, 1909, new name for *C. sowerbyi* Kiener, not of Anton nor of Gray; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 227, 1909; Nautilus, Vol. 32, p. 24, 1918.

Pleistocene: Upper conglomerate member of Santa Rosalia district, (coll. by M. E. Touwaide); Magdalena Bay Pleistocene (Dall, 1918); both in Lower California, Mexico.

Recent: Gulf of California, Mexico, to Sechura Bay, Peru (Dall, 1909).

This species is distinguished from *C. spadicea* Swainson by its wider aperture, greater curving of the inner lip, and fewer teeth.

Cypræa arabicula Lamarck

Cypræa arabicula Lamarck, Ann. Mus. Hist. Nat. Paris, Vol. 16, p. 100, 1810; Hist. Anim. s. Vert., Vol. 7, p. 399, 1822; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 175, pl. 9, figs. 35, 36, 1885; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 227, 1909.

Pleistocene: Upper Pleistocene of coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Gulf of California, Mexico, to Paita, Peru (Dall).

This is a rather small form with a strongly curved aperture and numerous teeth on the lips.

Genus TRIVIA "Gray," Broderip, 1837

Trivia Broderip, Penny Cyclopedia, Vol. 8, p. 256, 1837, *fide* Iredale, Proc. Malac. Soc. London, Vol. 12, p. 35, 1916; Gray, Proc. Malac. Soc. London, Pt. 15, p. 142, 1847.

Type (by subsequent designation, Gray, 1847), *Cypræa europæa* Montagu (= *Voluta jonensis* Pennant), figured by Tryon, Man. Conch., Ser. 1, Vol. 7, p. 205, pl. 23, figs. 48-51, 1885, coasts of Europe, Recent.

Shell subglobular, cross-ribbed, front of columella internally concave, ribbed. (Tryon.)

The species of this genus are like those of *Cypræa* in outward appearance, except that they are marked by strong circular ridges and are usually smaller.

Trivia californiana (Gray)

Cypræa californiana Gray, Zool. Journ., Vol. 3, pt. 11, p. 365, December 31, 1827.
Trivia californica Gray, Tryon, Man. Conch., Ser. 1, Vol. 7, p. 202, pl. 22, figs. 18, 19, 20, 1885; Keep, West Coast Shells, p. 60, figs. 44*a*, 44*b*, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 288, 1903.
Trivia californiana Gray, Dall, U. S. Nat. Mus., Bull. 112, p. 140, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 238, 1927.

Type specimen: In the British Museum.

Type locality: California, Recent.

Pleistocene: Upper San Pedro series of San Pedro (Arnold); upper Pleistocene of Santa Monica (in Oldroyd Collection at Stanford University); both Los Angeles County.
Recent: Crescent City, California, to west Mexico (Dall).

Trivia pustulata (Lamarck)

Cypræa pustulata Lamarck, Ann. Mus. Hist. Nat. Paris, Vol. 15, p. 101, 1810; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 197, pl. 20, figs. 45, 46, 52, 1885.

Pleistocene: Coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Mazatlan, Mexico, to Panama (Tryon).

This species is cross-ribbed on the apertural side of the shell but the reverse side has numerous pustules or rounded protuberances.

Trivia radians (Lamarck)

Cypræa radians Lamarck, Ann. Mus. Hist. Nat. Paris, Vol. 16, p. 102, 1810; Hist. Anim. s. Vert., Vol. 7, p. 402, 1822.
Trivia radians Lamarck, Tryon, Man. Conch., Ser. 1, Vol. 7, p. 202, pl. 22, figs. 13, 14, 1885; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 58, 1895; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 228, 1909; Nautilus, Vol. 32, p. 24, 1918; U. S. Nat. Mus., Bull. 112, p. 140, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 237, 1927.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall, 1918); coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Santa Barbara and Catalina Island, California, to Ecuador (Dall, 1921).

Trivia sanguinea (Gray in Sowerby)

Cypræa sanguinea Gray, in Sowerby's Conch. Illust., p. 13, fig. 32, 1832.
Trivia sanguinea Gray, Tryon, Man. Conch., Ser. 1, Vol. 7, p. 203, pl. 22, figs. 21, 22, 1885; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 228, 1909; U. S. Nat. Mus., Bull. 112, p. 140, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 237, 1927; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Catalina Island, California; Magdalena Bay, Lower California, to Salina Cruz, Mexico; Ecuador (Dall, 1921).

Trivia solandri (Gray in Sowerby)

Cypræa solandri Gray, in Sowerby's Conch. Illust., p. 15, pl. 7, fig. 43, 1832.
Trivia solandri Gray, Tryon, Man. Conch., Ser. 1, Vol. 7, p. 202, pl. 22, figs. 15, 16, 1885; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 289, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 228, 1909; U. S. Nat. Mus., Bull. 112, p. 140, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 238, 1927.

Pleistocene: Lower San Pedro series of Deadman Island, "one specimen" (Arnold), and upper Pleistocene of Santa Monica (Oldroyd Collection at Stanford University), Los Angeles County.
Recent: Catalina Island, California, to Panama (Dall, 1921); ? Peru (Dall, 1909).

Trivia ritteri Raymond

"*Trivia sanguinea* Gray," in part of early California collectors, not of Gray in Sowerby, 1832.
Trivia ritteri Raymond, Nautilus, Vol. 17, p. 85, 1903; Lowe, Vol. 18, p. 20, 1904; Dall, U. S. Nat. Mus., Bull. 112, p. 140, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 238, 1927.

Type specimen: In the collection at the University of California.

Type locality: Off Catalina Island, California, in 60 fathoms.

Pliocene: Upper Pliocene at Fifth and Hope streets, Los Angeles, California, three or four specimens (coll. by Charles M. Jay).
Recent: Monterey and San Pedro, California, to Cortez Bank (Dall).

This rare, white species is obtained in the living state only by dredging. The ribs are continuous across the back, the species differing in this respect from *T. californiana* (Gray). *T. sanguinea* (Gray in Sowerby), with which *ritteri* was formerly confused, is dark colored and the ribs are interrupted somewhat across the back. *T. californiana* has fewer and coarser ribs than either *ritteri* or *sanguinea*.

Genus ERATO Risso, 1826

Erato Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 240, 1826.

Type (by monotypy), *Erato cypræola* Risso, Italy, Miocene or Pliocene, figured by Risso, pl. 7, fig. 85.

This genus differs from *Cypræa* in that the spire is not entirely obscured by the extension of the aperture.

Erato columbella Menke

Erato columbella Menke, Zeitschr. f. Malakozool., Vol. 4, p. 183, Dec., 1847; Tryon, Man. Conch., Ser. 1, Vol. 5, p. 10, pl. 4, fig. 8, 1883; Keep, West Coast Shells, p. 61, fig. 46, 1888, 1892; Cooper, Seventh Ann. Rept. Calif. State Mineralogist, p. 240, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 289, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 140, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 240, 1927.

Type locality: Mazatlan, Mexico (*fide* Oldroyd).

Pleistocene: Santa Barbara (Cooper); upper San Pedro series of San Pedro, "one specimen" (Arnold); Santa Monica (in Oldroyd Collection at Stanford University); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California, to Panama Bay (Dall, 1921).

Family STROMBIDAE

Genus STROMBUS Linnæus, 1758

Strombus Linnæus, Syst. Nat., Ed. 10, p. 742, 1758; Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 72, 1799, *S. pugilis* L. only example; Syst. Anim. s. Vert., p. 80, 1801; Montfort, Conch. Syst., Vol. 2, p. 515, 1801.

Type (by subsequent designation, Montfort, 1810), *Strombus pugilis* Linnæus; Caribbean, Recent; also fossil in Oaxaca, Mexico.[1]

Strombus gracilior Sowerby

Strombus gracilior Sowerby, Cat. Shells Tankerville, Appen., p. xx, 1825; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 109, pl. 2, fig. 17, 1885; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 57, 1895; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 229, 1909; Nautilus, Vol. 32, p. 24, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 454, 1926.

Pliocene: Coyote Mountain, Imperial County (Hanna).
Pleistocene: Lower Pleistocene of Magdalena Bay (Dall; Jordan); upper Pleistocene of San Ignacio Lagoon (Jordan); both in Lower California, Mexico.
Recent: La Paz, Lower California, and Gulf of California, Mexico, to Manta, Ecuador.

This is a typical *Strombus*, it being the Pacific analogue of *S. pugilis* Linnæus, the type of the genus.

Strombus granulatus Mawe

Strombus granulatus Mawe, Linnæan Syst. Conch., pp. 125, 127, pl. 25, fig. 3, 1823; Gray, in Wood's Index Test., Suppl., pl. 4, fig. 1, 1828; Sowerby, Thes. Conch., Vol. 1, p. 33, pl. 9, fig. 100, 1842.
Strombus granulatus Gray, Tryon, Man. Conch., Ser. 1, Vol. 7, p. 110, pl. 3, fig. 22, 1885; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 57, 1895; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 229, 1909; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Type locality: California, Recent (Mawe).

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Gulf of California and Mazatlan, Mexico, to Manta, Ecuador, and Galapagos Islands.

This species has frequently been attributed to Gray, 1828; but Mawe seems to have had the same shell, which he named *S. granulatus* in 1823. There is a *Strombus granulatus* Swainson in the Appendix to the Bligh Catalogue, 1822, but this reference has not been available.

Strombus obliteratus Hanna

Strombus obliteratus Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 454, pl. 20, fig. 7, March 23, 1926.

Type specimen: In the collection of the California Academy of Sciences, No. 1809.

Type locality: Alverson Canyon, Coyote Mountain, Imperial County; Pliocene.

Pliocene: Imperial formation, Coyote Mountain, California (Hanna).

According to Hanna, this species is closely related to *S. granulatus*, but is shorter and stouter and has somewhat different and more prominent spinose sculpture. Thirty-three specimens of *obliteratus* were examined by Hanna, who observed no intergradation with *granulatus* in the differential characters mentioned.

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[1] Böse, Inst. Geol. Mexico, Bull. No. 22, p. 35, pl. 4, figs. 1-6, 1906. Pliocene at Tuxtepec, Oaxaca.

Strombus galeatus Swainson

Strombus galeatus W. Swainson, Philos. Mag., Vol. 62, p. 401, December, 1823; Reeve, Conch. Icon., Vol. 6, *Strombus*, pl. 3, fig. 3, 1850; Tryon, Man. Conch., Vol. 7, p. 108, pl. 1, fig. 6, 1885; Stearns, Proc. U. S. Nat. Mus., Vol. 17, p. 190, 1894; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 57, 1895; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 454, 1926; Hanna and Hertlein, Vol. 16, p. 143, 1927.

Pliocene: Imperial formation of Coyote Mountain, Imperial County (Hanna); Santa Antonita Point, Coronados Island, Carmen Island, and Ceralbo Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Gulf of California, Mexico (Stearns); Panama to Mazatlan, Acapulco (Tryon).

This is a large species with the aperture elongated so that the spire appears relatively low.

Family CLAVIDAE

Genus CERITHIUM Bruguière, 1789

Cerithium Bruguière, Ency. Méth. Hist. Nat. Vers, Vol. 1, p. xv, 1789, p. 467, 1792; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 355, 1927.

Stewart has shown that *Cerithium* Bruguière must be considered a synonym of *Clava* Martyn unless *Cerithium adansonii* Bruguière is adopted as type on the basis of indirect virtual tautonymy. As this method of type designation is ineffective when opposed to a valid subsequent designation, *Cerithium* must be dropped in favor of *Clava* unless a suspension of the rules is obtained. In anticipation of such a protective action on the part of the International Commission on Zoological Nomenclature, the generic name *Cerithium* is here used with *C. adansonii* Bruguière as type. Vignal,[1] Cossmann,[2] and others have used *C. adansonii* as the type of *Cerithium.*[3]

"Cerithium" adustum Kiener

Cerithium adustum Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, *Cerite*, p. 37, pl. 13, fig. 2, 1841 (or 1842?); Tryon, Man. Conch., Ser. 1, Vol. 9, p. 126, pl. 21, fig. 52, not fig. 51, 1887; Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 57, 1895; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Magdalena Bay, Lower California, Mexico, to Panama and the Galapagos Islands.

Kiener's figure of this species is of a dark shell with a few small nodosities, a rather deep, straight posterior canal, and a short, straight anterior canal. It does not have the strong nodosities of *"C." maculosum* Kiener. Kiener gave the habitat as the Indian Ocean and Red Sea, which appears to be an error. Tryon gives the range as Mazatlan to Panama and the Galapagos Islands. Jordan reported the species as Recent at Magdalena Bay.

"Cerithium" stercus-muscarum Valenciennes

Cerithium stercus-muscarum Valenciennes, in Rec. Observ. Zool., Humboldt et Bonpland, Vol. 2, p. 278, 1833; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 229, 1909; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 142, 1927.

Type locality: Acapulco, Mexico, Recent.

Pliocene: Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Cedros Island, Lower California, Mexico, to Tumbes, Peru, and the Galapagos Islands (Dall).

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[1] Journ. de Conchyl., Vol. 58, pp. 138-140, 1910.

[2] Ann. Soc. Roy. Malac. Belg., Vol. 24, p. 10, 1889.

[3] In addition to Stewart's discussion referred to above the reader should consult Dall, "On the Synonymic History of the Genera *Clava* Martyn and *Cerithium* Bruguière," Proc. Acad. Nat. Sci. Phila., 1907, pp. 363-369, 1907. E. Wood has published some interesting information on "The Phylogeny of Certain *Cerithiidæ*" in Vol. 20 of the New York Academy of Sciences, 1910.

"Cerithium" ocellatum Bruguière

Cerithium ocellatum Bruguière, Ency. Méth. Hist. Nat. Vers, Vol. 1, p. 499, 1792; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 132, pl. 24, fig. 19, 1887; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 57, 1895; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 229, 1909; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 149, 151, 1924.

Pleistocene: Lower Quaternary at Magdalena Bay and upper Quaternary at San Ignacio Lagoon, Lower California, Mexico (Jordan).

Recent: Lower California, Mexico, to Panama and the Galapagos Islands.

"Cerithium" simplicius, new species

Plate 24, Figure 11

Shell of medium size, high spired; whorls moderately ventricose, particularly on the upper half of each whorl, the lower half being nearly straight in profile; sculptured with numerous, fine, equally spaced spiral striations, about 16 to 18 per whorl, and very low broad axial undulations which probably represent the parietal callus pile deposited during resting stages, their being three or four per whorl, all somewhat concentrated axially at about a quarter of the distance from the upper to the lower suture; aperture imperfect, but clearly showing a small anterior canal, which is slightly twisted to the left, and a callus deposit on the parietal wall at the position of the posterior canal, which, during growth, produces the low bulges mentioned above.

Dimensions of type specimen: Altitude (incomplete), 32 mm.; maximum diameter, 13 mm.

Type specimen: No. 207, in the collection of the San Diego Society of Natural History.

Type locality: S. D. S. N. H. locality 217*b*, Holser Canyon, north side of Santa Clara Valley, Los Angeles County, middle Pliocene.

Pliocene: Middle Pliocene at the type locality, the type and several paratypes (H. R. G.).

The most characteristic feature of this interesting species is its lack of axial ribs. It is entirely unlike the strongly nodulose species from the Mexican coast. It does not have the flange-like anterior canal nor the axial ribs of *Cerithidea californica* (Haldeman), and indeed it is much larger and entirely unlike that species. The writers know of no species that is at all similar to *simplicius*. It is far from being a typical "*Cerithium*," but until better specimens are available it is placed here tentatively.

Genus THERICIUM Rochebrune in Monterosato, 1890

Thericium Rochebrune, Monterosato, Naturalista Siciliano, Year 9, no. 7, p. 163, 1890; Woodring, Carnegie Inst., Publ. No. 385, p. 332, 1928.

Vulgocerithium Cossmann, Ess. Paléo. Comp., Vol. 7, p. 77, 1906.

Type (by original designation), *Cerithium vulgatum* Bruguière, Mediterranean, Recent (*fide* Woodring); figured by Reeve, Conch. Icon., Vol. 15, *Cerithium*, pl. 2, fig. 9, 1865.

If *Cerithium* is retained by a suspension of the International Rules of Nomenclature, *Thericium* should probably be considered at most a subgenus. In examining a representative collection of Cerithioids, it will be noticed that the apertural and sculptural characters occur in somewhat confusing combinations, and it is likely that a separation of *Thericium* is more artificial than natural. The family is in need of a critical review, which would far exceed the time and space limitations of this paper.

Thericium incisum (Sowerby)

Cerithium incisum Sowerby, Thes. Conch., Vol. 2, p. 868, pl. 182, fig. 152, 1855; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 142, pl. 27, fig. 22, 1887; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 445, 1926.

Pliocene: Coyote Mountain, Imperial County (Hanna).

Recent: Lower California and Guaymas, Mexico (Tryon).

"*Cerithium*" *sculptum* and *curtum* Sowerby are both much shorter shells than *incisum*, according to Sowerby's figures, though *curtum* may be a variety or variant of *incisum*.

Genus CLAVA Martyn, 1784

Clava Martyn, Univ. Conch., Vol. 1, Nos. 12, 13, 1784; Pilsbry, Proc. Acad. Nat. Sci. Phila. for 1901, p. 392.

Type (by subsequent designation, Pilsbry, 1901), *Clava rugata* Martyn.

Clava gemmata (Hinds)

Cerithium gemmatum Hinds, Zool. Voy. Sulphur, Moll., p. 27, 1844; Dall, Nautilus, Vol. 32, p. 24, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.
Cerithium (Vertagus) gemmatum Hinds, Tryon, Man. Conch., Ser. 1, Vol. 9, p. 146, pl. 28, fig. 44, 1887.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall; Jordan, as lower Pleistocene).
Recent: Gulf of California, Mexico, to Panama (Jordan).

The well-developed spiral lamina on the columella and the reflexed anterior canal place this species in *Clava* Martyn. It is the type of the subgenus *Ochetoclava* Woodring,[1] characterized by the shorter and less horizontal canal and strongly ascending outer lip, which produces a long posterior channel.

Clava? lordii (Yates),[2] a form described from a single beach-worn specimen retaining only the body whorl and part of the penultimate whorl, appears as figured to be somewhat like *C. gemmata;* but it has more numerous rows of nodules. It came from the Santa Barbara Channel near Ellwood, Santa Barbara County. It may have been a ballast shell or a fossil washed out on the beach. *Potamides cyclus* Dall may be a synonym of *lordii.*[3]

Genus DIASTOMA Deshayes, 1861

Diastoma fastigiatum (Carpenter)

Bittium fastigiatum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 5, p. 181, 1865.
Diastoma fastigiata Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 39, p. 581, text fig. 1, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 144, 1921.

Pleistocene: Santa Barbara (Carpenter; Bartsch, as "lower Pleistocene," ? probably upper Pliocene).
? Recent: Santa Barbara, California.

Genus ALABINA Dall, 1902

Elachista Dall and Bartsch, Nautilus, Vol. 15, p. 58, September, 1901, not *Elachista* Treitschke, 1833.
Alabina Dall, Nautilus, Vol. 15, p. 127, 1902.

Type (by original designation), *Bittium cerithidioide* Dall, Florida, Pliocene and Recent.

Alabina barbarensis Bartsch

Alabina barbarensis Bartsch, Proc. U. S. Nat. Mus., Vol. 39, p. 411, pl. 61, fig. 3, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 145, 1921.

Pleistocene: Santa Barbara (Bartsch), probably upper Pliocene.
? Recent: Santa Barbara, California.

Alabina californica (Dall and Bartsch)

Bittium (Elachista) californicum Dall and Bartsch, Nautilus, Vol. 15, p. 58, 1901.
Bittium californicum Dall and Bartsch, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 291, pl. 4, fig. 4, 1903.
Alabina californica Dall and Bartsch, Bartsch, Proc. U. S. Nat. Mus., Vol. 39, p. 414, pl. 62, fig. 7, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 145, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925.

Pleistocene: Lower San Pedro series at San Pedro (Arnold), at Nob Hill cut (Oldroyd), and Deadman Island (Bartsch, 1911).
Recent: San Diego (Gripp ?).

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[1] Carnegie Inst. Wash., Publ. No. 385, p. 334, 1928; type (by original designation) *Cerithium gemmatum* Hinds.

[2] *Vertagus lordii* Yates, Santa Barbara Soc. Nat. Hist., Bull. No. 2, p. 47, pl. 2, figs. 6, 7, August, 1890.

[3] Proc. U. S. Nat. Mus., Vol. 56, p. 346, 1919; Long Beach, California, to Gulf of California.

Alabina hamlini Bartsch

Alabina hamlini Bartsch, Proc. U. S. Nat. Mus., Vol. 39, p. 411, pl. 61, fig. 2, 1911; Dall, Bull. 112, U. S. Nat. Mus., p. 145, 1921.

Pleistocene: "The type and 19 specimens . . . . were collected in the Post-Pliocene deposits at Hallenbeck's well, Los Angeles, California" (Bartsch).

Alabina io Bartsch

Alabina io Bartsch, Proc. U. S. Nat. Mus., Vol. 39, p. 415, pl. 61, fig. 1, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 145, 1921.

Pleistocene: "Post-Pliocene beds of San Diego, California" (Bartsch); "Signal Hill, Long Beach, California, Pleistocene" (Dall).

Alabina monicensis Bartsch

Alabina monicensis Bartsch, Proc. U. S. Nat. Mus., Vol. 39, p. 415, pl. 62, fig. 5, 1911.

Pleistocene: Upper San Pedro series at Santa Monica, Los Angeles County (Bartsch).

Genus BITTIUM Leach, in Gray, 1847

Bittium Leach, Gray, Ann. Mag. Nat. Hist., Vol. 20, p. 270, October, 1847; Proc. Zool. Soc. London for 1847, p. 154, November, 1847.

Type (by subsequent designation, Gray, Nov., 1847), *Murex reticulatus* Montagu (= *Strombiformis reticulatus* Da Costa), European seas, Recent.

Bartsch[1] has given the following key to the subgenera of *Bittium* occurring on the Pacific coast of North America:

Nuclear whorls with two spiral lirations:
    Postnuclear whorls having varices. . . . .*Bittium, s. s.*
    Postnuclear whorls without varices. . . . .*Lirobittium* Bartsch
Nuclear whorls smooth:
    Spiral sculpture predominating over axial. . . . .*Stylidium* Dall
    Spiral sculpture not predominating over axial. . . . .*Semibittium* Cossmann

These subdivisions are probably entirely artificial and should be discarded as soon as a natural classification can be worked out, if not before. *B. asperum*, for instance, has its specific relatives in *Semibittium*, but is classed in *Lirobittium*.

Subgenus **LIROBITTIUM** Bartsch, 1911

Lirobittium Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 384, 1911.

Type (by original designation), *B. catalinense* Bartsch, 1907.

Bittium (Lirobittium) catalinense Bartsch

Bittium catalinensis Bartsch, Smithsonian Misc. Coll., Quarterly Issue, Vol. 50, Pt. 4, p. 28, pl. 57, fig. 13, 1907.

Bittium (*Lirobittium*) *catalinense* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 402, pl. 51, fig. 1, 1911; Dall, Bull. 112, U. S. Nat. Mus., p. 147, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925.

Bittium (*Lirobittium*) *catalinense inornatum* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 403, pl. 51, fig. 3, 1911; Dall, U. S. Nat. Mus. Bull. 112, p. 147, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 32, pl. 75, fig. 3, 1927.

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[1] "The Recent and Fossil Mollusks of the Genus Bittium from the West Coast of America." Proc. U. S. Nat. Mus., Vol. 40, pp. 383-414, pls. 51-58, May 12, 1911.

Pleistocene: Lower San Pedro series of Deadman Island (Bartsch), and of Nob Hill cut (Oldroyd); Santa Barbara and San Diego (Bartsch).
Recent: Catalina Island to San Diego, California (Dall).

Bittium (*Semibittium*) *subplanatum* Bartsch is probably closely related to this species. The variety *inornatum* Bartsch is of little significance.

Bittium (Lirobittium) ornatissimum Bartsch

Bittium (*Lirobittium*) *ornatissimum* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 403, pl. 52, figs. 4, 5, 1911; Dall, Bull. 112, U. S. Nat. Mus., p. 147, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925.

Pleistocene: Lower San Pedro series of Deadman Island (Bartsch) and of Nob Hill cut (Oldroyd), San Pedro, Los Angeles County; Santa Barbara (Bartsch).
Recent: San Pedro (Dall).

Bittium (Lirobittium) interfossum (Carpenter)

Rissoa interfossa Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 656, 1864.
Cerithiopsis fortior Carpenter, *op. cit.*, p. 660, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 337, 1865.
Rissoina interfossa Carpenter, Proc. Calif. Acad. Sci., Vol. 3, p. 217, 1866.
Bittium (*Lirobittium*) *interfossa* Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 401, pl. 51, figs. 2, 6, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 147, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey to San Diego, California (Dall); San Martin Island, Lower California, Mexico (F. C. Baker).

Bittium (Lirobittium) asperum (Gabb)

Turbonilla aspera Gabb, Proc. Acad. Nat. Sci. Phila. for 1861, p. 368.
Bittium asperum Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 12, pl. 2, fig. 20, 1866; Tryon, Man. Conch., Vol. 9, p. 153, pl. 30, fig. 7, 1887; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 230, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 291, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914, not positively identified; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 357, pl. 32, fig. 7, text fig. 4, 1927.
Bittium barbarense Bartsch, Smithsonian Misc. Coll., Quarterly Issue, Vol. 50, Pt. 4, p. 28, pl. 57, fig. 15, 1907.
Bittium (*Lirobittium*) *asperum* Gabb, Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 405, pl. 56, fig. 3, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 147, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 78, 79, 1929.

Pliocene: "Pico" formation near Ventura (Waterfall); questionably at Holser and Elsmere canyons, Los Angeles County (English); San Diego well, San Diego (Dall); Santa Barbara, probably in uppermost Pliocene (Arnold; Berry; Bartsch); etc.
Pleistocene: Santa Barbara to San Diego (Cooper); "Pliocene" of Deadman Island and Timm's Point; lower San Pedro series at Deadman Island, "rare"; Barlow's Ranch, near Ventura; upper San Pedro series at Crawfish George's and San Pedro; Pacific Beach, San Diego (Arnold).
Recent: As variety *lomaënse* Bartsch, 1911, and probably also the typical variety; Catalina Island to San Diego, California.

Bittium (Lirobittium) asperum (Gabb) variety **dilatatum,** new variety

Plate 24, Figure 14

Shell like that of the typical variety but relatively much shorter and broader, with coarser sculpture, fewer spirals, and fewer axials. Length, about 6 mm. (specimen incomplete); width of last whorl, about 3 mm.

Type specimen: In the collection of the San Diego Society of Natural History, No. 210.

Type locality: S. D. S. N. H. locality 217*b*, at the head of Holser Canyon, Los Angeles County; middle Pliocene.

Pliocene: Middle Pliocene at the type locality (H. R. G.).

Notwithstanding the considerable number of named species, or supposed species, of *Bittium* from California, the specimen described above appears distinct enough to be of significance. It is probably not merely the young of some other form, for the early whorls of larger shells do not have such strong sculpture nor such a dilated angle.

Subgenus **STYLIDIUM** Dall, 1907

Stylidium Dall, in Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 178, October 23, 1907; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 76, April 2, 1909.

Type (by original designation), *Bittium eschrichtii* (Middendorff).

Of the subgenera of *Bittium* now in use, this one alone seems to be recognizable, and yet it is probably of little more than specific value.

Bittium (Stylidium) eschrichtii (Middendorff)

Plate 24, Figure 9

Cerithium filosum Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 120, 1849, not *Cerithium filosum* Philippi, Zeitschr. f. Malakozool. for 1848, p. 143, March, 1849.

Turritella eschrichtii Middendorff, Mém. Acad. Imp. Sci., St. Pétersb., Vol. 8, p. 396, pl. 11, fig. 1, August, 1849.

Bittium filosum Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 152, pl. 29, fig. 90, 1887; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 230, 1888; Keep, West Coast Shells, p. 72, fig. 57, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 292, 1903; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 239, 1916.

Bittium (Stylidium) eschrichtii Middendorff, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 76, pl. 14, fig. 2, 1909; Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 387, pl. 58, fig. 4, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 145, 1921.

Stylidium eschrichti Middendorff, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 593, 1913.

Pliocene: Merced-Purisima south of San Francisco (Arnold and Hannibal); Coos conglomerate at Fossil Rock, Coos Bay, Oregon, possibly Pleistocene (Dall); upper Wildcat formation, Humboldt County (Martin).

Pleistocene: Rare in lower and upper San Pedro series at Deadman Island and San Pedro; "a few found at Crawfish George's," Los Angeles County (Arnold); Santa Barbara (Cooper).

Recent: Sitka, Alaska, to Puget Sound (Dall, 1921).

Berry's report of this species at Monterey may refer to the variety *montereyense* Bartsch.

Bittium (Stylidium) eschrichtii (Middendorff) variety **montereyense** Bartsch

Bittium (Stylidium) eschrichti montereyensis Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 178, 1907.

Bittium (Stylidium) eschrichtii montereyense Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 389, pl. 58, fig. 5, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 146, 1921.

? Pliocene: Ubi ? (Dall, 1921).

Pleistocene: Deadman Island, Los Angeles County (Bartsch, 1911).

Recent: Crescent City, California, to Cape San Lucas, Lower California, Mexico (Dall, 1921).

Dall reported this species as Pliocene but gave no locality. Probably his record referred to the Deadman Island Pleistocene occurrence.

Subgenus **SEMIBITTIUM** Cossmann, 1896

Semibittium Cossmann, Cat. Illust. Coq. Foss. Env. Paris, App. 2, p. 29, 1896; Ess. Paléo. Comp., Vol. 7, p. 138, 1906.

Type, Cerithium cancellatum Lamarck, Eocene of France.

Bittium (Semibittium) armillatum Carpenter

Bittium armillatum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 18, p. 276, 1866; Baker, Nautilus, Vol. 16, p. 41, 1902.

Bittium (*Semibittium*) *armillatum* Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 391, pl. 52, fig. 6, 1911.

? Semibittium armillatum Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 146, 1921.

? Upper Pliocene: Santa Barbara (type locality).

Pleistocene: ? Santa Barbara (Carpenter, type locality; Bartsch); San Pedro (Bartsch).

Recent: ? "Santa Barbara and San Pedro, California. Pleistocene" (Dall); San Martin Island, Lower California, Mexico (Baker).

Bittium (Semibittium) attenuatum Carpenter

Bittium attenuatum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864; Journ. de Conchyl., Vol. 12, p. 242, 1865; Baker, Nautilus, Vol. 16, p. 41, 1902; Lowe, Vol. 27, p. 27, 1913; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925.

Bittium (? var.) *esuriens* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 181, 1865; Journ. de Conchyl., Vol. 12, p. 242, 1865.

Bittium (*Semibittium*) *attenuatum* Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 393, pl. 54, figs. 1, 2, 5, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 146, 1921.

Pleistocene: Lower San Pedro series of Deadman Island (Bartsch) and of Nob Hill cut, San Pedro (T. S. Oldroyd), Los Angeles County.

Recent: Forrester Island, Alaska, to San Diego, California (Dall); San Martin Island (Baker) and San Geronimo Island (Lowe), Lower California, Mexico.

Bittium (Semibittium) rugatum Carpenter

Plate 24, Figure 8

Bittium rugatum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 539, 1864, list name; Ann. Mag. Nat. Hist., Ser. 3, Vol. 17, p. 276, 1866; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 295, pl. 4, fig. 11, 1903; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Bittium (*Semibittium*) *rugatum* Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 397, pl. 56, figs. 4, 5, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 146, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925.

? Pliocene: Santa Barbara (Carpenter—It is not known exactly where Carpenter's material came from, and it may have been Pleistocene).

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro, "common" (Arnold); Nob Hill cut, San Pedro (T. S. Oldroyd); Santa Barbara (Bartsch); upper San Pedro series of San Pedro region (Arnold); San Diego (Bartsch); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan); upper Pleistocene southwest of Goleta, Santa Barbara Co.

Recent: San Pedro and Catalina Island (Dall).

Bittium (Semibittium) quadrifilatum Carpenter

Bittium quadrifilatum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864; Journ. de Conchyl., Ser. 3, Vol. 5, p. 143, 1865; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 153, pl. 29, fig. 91, 1887; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 230, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 205, pl. 21, fig. 4, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 292, pl. 9, fig. 2, 1903.

Bittium (*quadrifilatum* Cpr. ?) Berry, Nautilus, Vol. 22, p. 38, 1908.

Bittium (*Semibittium*) *quadrifilatum* Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 398, pl. 58, figs. 2, 3, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 146, 1921.

Pliocene: Bath-house Beach, Santa Barbara (Arnold).

Pleistocene: Lower and upper San Pedro series of San Pedro region, Los Angeles County (Arnold).

Recent: Monterey, California, to San Ignacio Lagoon, Lower California, Mexico (Dall).

Bittium (Semibittium) larum Bartsch

Bittium (*Semibittium*) *larum* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 407, pl. 57, fig. 4, 1911.

Bittium larum (?) Bartsch, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924.

? Pleistocene: Lower Quaternary at Magdalena Bay, Lower California (Jordan, doubtfully identified by Bartsch).

Recent: San Pedro, California, to San Bartolome Bay, Lower California, Mexico (Jordan).

This species is closely related to *Bittium* (*Lirobittium*) *catalinense* Bartsch which in turn is closely related to *Bittium* (*Semibittium*) *subplanatum* Bartsch. These specific relationships, which become apparent when a large number of specimens are examined, illustrate the artificial and misleading character of the supposed subgeneric divisions now in use.

INCERTAE SEDIS

Bittium giganteum Bartsch

Bittium giganteum Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 410, pl. 55, fig. 2, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 148, 1921.

Pleistocene: San Diego, the type locality; San Pedro (Bartsch).

Bittium casmaliense Bartsch

Bittium casmaliense Bartsch, *op. cit.*, p. 411, pl. 55, fig. 3, 1911.

Pliocene: Railroad cut one mile north of Schumann, Santa Barbara County (Bartsch).

Bittium arnoldi Bartsch

Bittium arnoldi Bartsch, *op. cit.*, p. 411, pl. 56, fig. 1, 1911.

Pliocene: Waldorf asphalt mine, three miles southeast of Guadalupe, Santa Barbara County (Bartsch).

Some of the species of *Bittium*, such as *B. sanjuanense* Bartsch, are difficult to separate from *Tachyrhynchus* Mörch, the differences being in the operculum. *Bittium* has a paucispiral operculum with the nucleus not central, while *Tachyrhynchus* has a multispiral operculum with a central nucleus.

Genus CERITHIDEA Swainson, 1840

Shell high spired, Turritelloid, of many regularly enlarging whorls; columella smooth, not plicated; outer lip sometimes thickened; anterior canal a narrow groove or reduced to a small flange.

Cerithidea californica (Haldeman)

Plate 24, Figures 6, 7

Cerithium californicum Haldeman, Monog. Freshwater Shells N. Amer., cover of No. 1, 1840.
Cerithium (*Potamis*) *sacratum* Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 118, 1849; U. S. Expl. Exped., Vol. 12, p. 114, 1852, Atlas, pl. 10, fig. 116, 1856.
Potamis pullatus Gould, U. S. Pacific R. R. Repts., Vol. 5, p. 333, pl. 11, figs. 23, 24, 1856.
Cerithidea californica Haldeman, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 79, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 233, 1888; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 277, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 296, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 148, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.
Cerithidea sacrata Gould, variety *hyporhyssa* Berry, Nautilus, Vol. 19, p. 132, text figure, 1906.

Pliocene: San Fernando, Los Angeles County (Cooper).
Pleistocene: San Pedro to San Diego (Cooper); "Pliocene," lower and upper San Pedro series of San Pedro region, very common in the upper San Pedro (Arnold); Newport Pleistocene (Strong and Grant); "Saugus" formation near Ventura (Waterfall); Twenty-sixth Street, Pacific Beach (Arnold), and east side of Mission Bay (Stephens), San Diego; lower Quaternary at Magdalena Bay and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1924, 1926); etc.
Recent: Baulinas Bay to San Diego, California (Dall, 1921); San Martin Island, Lower California, Mexico (F. Baker).

This species is often excessively abundant on mud flats in the bays of California. The variety *hyporhyssa* is an individual variant or a pathologic form with very subdued sculpture and a higher spire. It is not a valid variety.

Genus SEILA A. Adams, 1861

Seila montereyensis Bartsch

"*Cerithiopsis assimilata* C. B. Adams," Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 233, 1888, not *C. assimilata* C. B. Adams, 1852.

"*Seila assimilata* C. B. Adams," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 290, pl. 4, fig. 8, 1903; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; not of C. B. Adams, 1852.

Seila montereyensis Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 176, October 23, 1907; Dall, U. S. Nat. Mus., Bull. 112, p. 144, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 15, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pliocene: Fifth and Hope streets, Los Angeles, lower part of upper Pliocene (U. S. G.).

Pleistocene: Lower San Pedro series at Nob Hill cut (Oldroyd) and San Pedro (Arnold); San Diego (Cooper); Santa Monica (coll. of F. C. Clark); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to Todos Santos Bay, Lower California, Mexico (Dall).

This species is much larger than the true *S. assimilata* C. B. Adams, of the Panama region.

Family CERITHIOPSIDAE

Genus CERITHIOPSIS Forbes and Hanley, 1853

Cerithiopsis Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 364, 1853.

Type (by monotypy), *Murex tubercularis* Montagu, European Seas, Recent.

Section CERITHIOPSIS, s. s.

Cerithiopsis fatua Bartsch

Cerithiopsis (*Cerithiopsis*) *fatua* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 331, pl. 36, fig. 5, May 8, 1911.

Cerithiopsis fatua Bartsch, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 15, 1925.

Pleistocene: Lower San Pedro series of Deadman Island (Bartsch) and Nob Hill cut, San Pedro (Oldroyd).

Cerithiopsis halia Bartsch

Cerithiopsis (*Cerithiopsis*) *halia* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 344, pl. 40, fig. 8, 1911.

Cerithiopsis halia Bartsch, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Todos Santos Bay to Cape San Lucas, Lower California, Mexico (Bartsch).

Cerithiopsis grippi Bartsch

Cerithiopsis (*Cerithiopsis*) *grippi* Bartsch, Proc. U. S. Nat. Mus., Vol. 52, p. 669, pl. 46, fig. 12, 1917.

Cerithiopsis grippi Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 143, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: San Diego, California (Bartsch).

Cerithiopsis montereyensis Bartsch

Cerithiopsis montereyensis Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 363, pl. 41, fig. 5, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 143, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Little River, Mendocino County, to Monterey, California (Dall).

Section CERITHIOPSIDA Bartsch, 1911

Cerithiopsida Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 329, 1911.

Type (by original designation), *Cerithiopsis* (*Cerithiopsida*) *diegensis* Bartsch.

Cerithiopsis diegensis Bartsch

Cerithiopsis (*Cerithiopsida*) *diegensis* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 347, pl. 40, fig. 4, 1911.
Cerithiopsis diegensis Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 143, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro to San Clemente Island, California, south to South Coronado Island, Lower California, Mexico (Dall).

Section CERITHIOPSINA Bartsch, 1911

Cerithiopsina Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 328, 1911.

Type, *Cerithiopsis necropolitana* Bartsch.

Cerithiopsis necropolitana Bartsch

Cerithiopsis (*Cerithiopsina*) *necropolitana* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 345, pl. 39, fig. 1, 1911.
Cerithiopsis necropolitana Bartsch, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 15, 1925.

Pleistocene: Lower San Pedro series of Deadman Island (Bartsch) and of Nob Hill cut (Oldroyd), San Pedro.

Section CERITHIOPSIDELLA Bartsch, 1911

Cerithiopsidella Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 329, 1911.

Type (by original designation), *Cerithiopsis cosmia* Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 180, 1907; Vol. 40, p. 348, pl. 38, fig. 7, 1911, Monterey, California, to Lower California, Mexico, Recent.

Cerithiopsis antefilosa Bartsch

Cerithiopsis (*Cerithiopsidella*) *antefilosa* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 349, pl. 40, fig. 9, 1911.
Cerithiopsis antefilosa Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 143, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro to San Diego, California (Dall).

Cerithiopsis alcima Bartsch

Cerithiopsis (*Cerithiopsidella*) *alcima* Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 350, pl. 39, fig. 2, 1911.
Cerithiopsis alcima Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 144, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro, California, to San Geronimo Island, Lower California, Mexico.

Section ?

Cerithiopsis fossilis Bartsch

Cerithiopsis fossilis Bartsch, Proc. U. S. Nat. Mus., Vol. 40, p. 353, pl. 38, fig. 3, 1911; T. S. Oldroyd, Vol. 65, Art. 22, p. 15, 1925.

Pleistocene: Lower San Pedro series of Deadman Island (Bartsch) and of Nob Hill cut near San Pedro (Oldroyd), Los Angeles County.

Cerithiopsis williamsoni (Arnold)

Bittium williamsoni Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 295, pl. 6, fig. 11, 1903.
Cerithiopsis williamsoni Arnold, Bartsch, Proc. U. S. Nat. Mus., Vol. 40, pl. 39, fig. 6, 1911.

Pleistocene: Upper San Pedro series of San Pedro; Spanish Bight, San Diego (Arnold).

Genus METAXIA Monterosato, 1884

Metaxia Monterosato, Nomen. Gen. Spec. Conch. Medit., p. 125, 1884; Cossmann, Ess. Paléo. Comp., Vol. 7, p. 148, 1906.

Type (by subsequent designation, Cossmann, 1906), *Cerithium rugulosum* Sowerby (+ "*Cerithiopsis metaxæ* Delle Chiaje" Monterosato, *ante* 1884, possibly not *Murex metaxa* S. Delle Chiaje, Mem. An. s. Vert. Napoli, Vol. 3, p. 222, 1828).

Metaxia diadema Bartsch

Metaxia diadema Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 182, 1907; Dall, U. S. Nat. Mus., Bull. 112, p. 144, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 15, 1925.

Pleistocene: Lower San Pedro series at Nob Hill cut, San Pedro (T. S. Oldroyd); palisades of Santa Monica (collection of F. C. Clark), both in Los Angeles County.
Recent: Monterey to San Diego, California (Bartsch).

Family TRIPHORIDAE

Genus TRIPHORA Blainville, 1828

Triphora Blainville, Dict. Sci. Nat., Vol. 55, p. 344, 1828.

Type (by monotypy), *Triphora gemmatum* Blainville (= *Cerithium tristoma* Blainville), Mauritius, Recent.

The shells of this group are small, slender, and sinistral, with small apertures and usually beaded sculpture. They are primarily a warm-water group, though some species venture into cool temperate waters.

Triphora pedroana (Bartsch)

Triphoris pedroanus Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 250, pl. 16, fig. 1, Dec. 12, 1907.
Trifora pedroana Bartsch, Dall. U. S. Nat. Mus., Bull. 112, p. 142, 1921.

Pleistocene: Upper San Pedro series at the lumber yard, San Pedro, Los Angeles County (Bartsch).
Recent: San Pedro, California, to South Coronado Island, Mexico, just south of Point Loma (Dall).

Triphora carpenteri (Bartsch)

"*Trifaris adversa* Montagu," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 628, in part, 1864, probably not of Montagu; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 290, 1903.
Triphoris carpenteri Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 252, pl. 16, fig. 16, 1907.
Trifora carpenteri Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 142, 1921.

Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles County, "one imperfect specimen" (Arnold).
Recent: Neah Bay, Washington.

Triphora catalinensis (Bartsch)

Triphoris catalinensis Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 253, pl. 16, fig. 18, 1907.
Trifora catalinensis Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 142, 1921.
Triphora catalinensis Bartsch, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Catalina Island and Laguna Beach, California.

Triphora stearnsi (Bartsch)

Triphoris stearnsi Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 254, pl. 16, fig. 3, 1907.
Trifora stearnsi Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 142, 1921.
Triphora stearnsi Bartsch, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: With the preceding species (Jordan).
Recent: San Diego, California, to the Gulf of California, Mexico (Dall).

Family TRICHOTROPIDAE

Genus TRICHOTROPIS Sowerby, 1829

Trichotropis Sowerby, Zool. Journ., Vol. 4, p. 373, 1829; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 76, 1909.

Trichotropis oregonensis (Conrad)

Cancellaria ? oregonensis Conrad, Amer. Journ. Conch., Vol. 1, p. 151, 1865, refers to unnamed figure in Geol. U. S. Expl. Exped., Atlas, pl. 20, fig. 8, 1849, a reversed figure or a figure of an exterior impression in a rock.
Trichotropis oregonensis Conrad, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 77, 1909.

Oligocene or *Miocene:* Concretions from the Astoria group at Astoria, Oregon (Dall).

Trichotropis insignis Middendorff

Trichotropis insignis Middendorff, Bull. Phys. Math. Acad. Imp. Sci. St. Pétersb., Vol. 8, p. 18, 1849; Dall, in Moffit, U. S. Geol. Surv., Bull. 533, p. 46, 1913; U. S. Nat. Mus., Bull. 112, p. 148, 1921.

Pliocene: Center Creek and second beach a half mile east of Nome, Alaska (Dall, in Moffit).
Recent: From Bering Strait south, on the west to northern Japan, and on the east to the Aleutian Islands and Cooks Inlet, Alaska (Dall, 1921).

Trichotropis kroyeri Philippi

Trichotropis kroyeri Philippi, Zeitschr. f. Malakozool. for 1848, p. 175, March, 1849.
Iphinoe kroyeri Philippi, Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; U. S. Nat. Mus., Bull. 112, p. 149, 1921

Pliocene: Late Pliocene of St. George Island, Pribilof group (Dall, 1919).
Recent: Arctic and Bering seas, eastward to the Shumagin Islands (Dall, 1921).

Family RISSOIDAE

Genus CINGULA Fleming, 1828

Cingula martyni Dall

Cingula robusta Dall MS., Krause, Arch. f. Naturg. for 1885, p. 270, pl. 17, fig. 1*a-b;* not *Cingula robusta* H. C. Lea, 1844.
Cingula robusta martyni Dall, Proc. U. S. Nat. Mus., Vol. 9, p. 306, pl. 3, fig. 9, 1886.
Cingula martyni Dall, Bartsch, Proc. U. S. Nat. Mus., Vol. 41, p. 485, 1912; Dall, U. S. Nat. Mus., Bull. 112, p. 157, 1921.
Cingula robusta Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919.

Pliocene: Late Pliocene of St. George Island, Pribilof group (Dall, 1919).
Recent: Bering Strait to the Aleutians and eastward to Chignik Bay, Alaska (Dall, 1921).

Genus ALVANIA (Leach) Risso, 1826

Alvania Leach MS., Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 140, 1826.

Alvania pedroana Bartsch

Alvania pedroana Bartsch, Proc. U. S. Nat. Mus., Vol. 41, p. 341, pl. 29, fig. 4, 1911; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: "The type and another specimen . . . . are fossils and came from sand rock, San Pedro, California" (Bartsch); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Alvania montereyensis Bartsch

Alvania montereyensis Bartsch, Proc. U. S. Nat. Mus., Vol. 41, p. 343, pl. 30, fig. 2, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 159, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County (T. S. Oldroyd).
Recent: Sitka, Alaska, to Monterey, California (Dall).

Alvania fossilis Bartsch

Alvania fossilis Bartsch, Proc. U. S. Nat. Mus., Vol. 41, p. 349, pl. 31, fig. 8, 1911.

Pleistocene: Sand rock, San Pedro (Bartsch).

Alvania acutilirata (Carpenter)

Rissoa acutilirata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 656, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 217, 1866; Baker, Nautilus, Vol. 16, p. 41, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 305, pl. 4, fig. 12, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908.
Alvania acutilirata Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 41, p. 352, pl. 31, fig. 3, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 159, 1921; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: "Pico" formation near Ventura (Waterfall); Bath-house Beach, Santa Barbara (Berry).
Pleistocene: Old irrigation ditch at Ventura (Arnold); "Saugus" formation near Ventura (Waterfall); upper San Pedro series of San Pedro (Arnold).
Recent: San Diego, California, to San Martin Island, Lower California, Mexico (Baker).

Alvania purpurea Dall

Alvania purpurea Dall, Amer. Journ. Conch., Vol. 7, p. 116, 1872; Bartsch, Proc. U. S. Nat. Mus., Vol. 41, p. 353, pl. 31, fig. 1, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 159, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California, to San Martin Island, Lower California, Mexico (Dall, 1921).

Alvania æquisculpta Keep

Alvania æquisculpta Keep, West Coast Shells, p. 65, 1888; Bartsch, Proc. U. S. Nat. Mus., Vol. 41, p. 358, pl. 32, fig. 7, 1911; Dall, U. S. Nat. Mus., Bull. 112, p. 159, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art 22, p. 17, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.
Rissoa æquisculpta Carpenter, Baker, Nautilus, Vol. 16, p. 41, 1902.
Rissoa (*Alvania*) *grippiana* Dall, Nautilus, Vol. 21, p. 136, 1908.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro (T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Catalina Island, California, to San Martin Island, Lower California, Mexico (Baker).

Family RISSOINIDAE

Genus RISSOINA d'Orbigny, 1840

Rissoina d'Orbigny, Voy. Amér. Mérid., Vol. 5, p. 395, 1840.

Type (by monotypy), *Rissoina inca* d'Orbigny, west coast of South America, Recent, figured by Bartsch, Proc. U. S. Nat. Mus., Vol. 49, p. 42, pl. 31, figs. 6, 8, 1915.

Rissoina kelseyi (Dall and Bartsch)

Rissoa kelseyi Dall and Bartsch, Nautilus, Vol. 16, p. 94, 1902.
Alaba oldroydi Dall, Nautilus, Vol. 19, p. 15, 1905.
Rissoina kelseyi Dall and Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 160, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1925.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd).
Recent: San Pedro, California, to the Coronado Islands, Lower California, Mexico (Dall, 1921).

Rissoina pleistocena Bartsch

Rissoina pleistocena Bartsch, Proc. U. S. Nat. Mus., Vol. 49, p. 54, pl. 32, fig. 2, 1915.

Pleistocene: "The type and another specimen . . . come from the lower Pleistocene of San Diego" (Bartsch), probably upper Pleistocene.

Rissoina dalli Bartsch

Rissoina dalli Bartsch, Proc. U. S. Nat. Mus., Vol. 49, p. 59, pl. 33, fig. 2, 1915; Dall, U. S. Nat. Mus., Bull. 112, p. 160, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro (Oldroyd).
Recent: San Pedro, California, to South Coronado Island, Lower California, Mexico (Dall).

Family TURRITELLIDAE

Genus TURRITELLA Lamarck, 1799

Turritella Lamarck, Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 74, 1799, sole species *Turbo terebra* Linnæus; Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 1, pt. 1, fasc. *b*, p. 224, 1884; Tryon, Man. Conch., Ser. 1, Vol. 8, pp. 192-209, 1886; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 78, 1909; Cossmann, Ess. Paléo. Comp., Vol. 9, p. 111 *et seq.*, 1912; Guillaume, Bull. Soc. Géol. France, Ser. 4, Vol. 24, pp. 281-311, pls. 10 and 11, 1924.

Turritellus Montfort, Conchyl. Syst., Vol. 2, pp. 210-212, figure, 1810, type, *Turritella terebra* Lamarck (*i. e.*, of Linnæus as *Turbo*).

Type (by monotypy), *Turritella terebra* (Linnæus), Syst. Nat., Ed. 10, p. 766, 1758; figured by Reeve, Conch. Icon., Vol. 5, *Turritella*, sp. 3, pl. 1, fig. 3, 1849, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 195, pl. 59, figs. 32, 33, 1886, etc.

Geologic range: Mesozoic to Recent.

Distribution: World wide, abundant in warm seas.

This well-known and widely-distributed genus[1] dates back at least as far as the Aptien (Lower Cretaceous) and possibly further. It is abundantly represented in the Tertiary. *Mesalia* Gray[2] differs from *Turritella* in its large apical angle and slightly developed anterior canal, which is absent on *Turritella*. *Mesalia* dates from the Cretaceous and is represented in the lower Eocene of California by *Turritella martinezensis* Gabb.[3] *Mathilda*[4] Semper differs from *Turritella* in its heterostrophus nucleus. *Arcotia* Stoliczka,[5] based upon a Cretaceous species of India, has a large apical angle and presumably straight growth lines.

A number of names have been proposed for subdivisions of *Turritella, s. l.,* based originally on differences in sculpture, but which do not permit of a natural grouping of the species unless correlated with the characters of the outer lip as reflected in the growth lines. B. Watson in the Challenger Report called attention to the importance of the sinuation of the outer lip, and Donald briefly discussed this feature and used it partly in differentiating her new section *Colpospira*.[6] In 1924, Guillaume published his important "Essai sur la Classification des Turritelles," in which the characters of the growth striæ are used for the recognition of five groups of *Turritella*. The reader is referred to this paper for what may prove to be a natural subdivision of a rather homogeneous group.[1]

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[1] Recently a number of "new genera" have been split off from *Turritella*. The significance and value of the "new genera" is yet to be shown.

[2] Synop. Cont. Brit. Mus., Ed. 44, p. 61, 1842, type *Cerithium Mesal* Adanson = *Mesalia brevialis* (Lamarck), designated by Gray, Proc. Zool. Soc. London for 1847, p. 155, 1847.

[3] Geol. Surv. Calif., Palæo., Vol. 2, pp. 169, 228, pl. 28, fig. 51, 1868-9. "*Mesalia*" *lincolnensis* Weaver, 1916, from the Oligocene of Washington, is an *Acrilla* (in the *Epitoniidæ*), *fide* Stewart, 1927. The type of *Acrilla* is *Scalaria acuminata* Sowerby.

[4] Semper, Journ. de Conchyl., Vol. 13, p. 330, 1865.

[5] Mem. Geol. Surv. India, Paleontologia Indica, "Cret. Gastr. So. India," p. 212, 1868, type, by original designation, *Arcotia indica* Stoliczka, p. 215, pl. 16, fig. 12, pl. 19, fig. 6, 1868.

[6] J. Donald, Proc. Malac. Soc. London, Vol. 4, no. 2, p. 51, August, 1900; type of *Colpospira*, by original designation, *Turritella runcinata* Watson, pl. 5, figs. 7, 7*a*.

Section HAUSTATOR Montfort, 1810

Haustator Montfort, Conchyl. Syst., Vol. 2, pp. 182-184, 1810; Guillaume, Bull. Soc. Géol. France, Ser. 4, Vol. 24, pp. 282, 290, 1924.

Type (by original designation) *Haustator gallicus* Montfort = *Turritella imbricataria* Lamarck, Eocene of Paris Basin; figured by Montfort.

Like *Turritella, s. s.*, but the growth lines having two points of inflection which are both quite near the sutures.

Geologic range: Cretaceous to Recent.

This section differs from the "groupe de *T. hybrida* Desh." in that the points of inflection of the growth lines are nearer the sutures. The sculptural characters (profiles of the whorls) appear to have a series of variations independent of the growth-line characters.

Turritella jewettii Carpenter

Plate 24, Figures 26, 27

Turritella jewettii Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 539, 655, 1864, reprinted in the Smithsonian Misc. Coll., No. 252, 1872; Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 17, p. 276, April, 1866; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 80, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 269, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 300, pl. 4, fig. 13, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 546, pl. 51, fig. 15, 1907; McLaughlin and Waring, Map folio accompanying Bull. 69, Calif. St. Mining Bureau, pl. 1, fig. 50, 1914; Dall, Bull. 112, U. S. Nat. Mus., p. 151, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, no. 7, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 54, 1927.

"*Turritella sanguinea* Reeve," Cooper, Calif. State Mining Bureau, Bull. No. 4, p. 32, 1894.

Type specimen: In the U. S. National Museum.

Type locality: Santa Barbara, Pleistocene or upper Pliocene.

Pliocene: San Diego well, Balboa Park, San Diego (Dall); "neighborhood of Santa Barbara . . . . two miles from the coast, and 150 feet high" (Carpenter, 1864, may be Pleistocene); San Pedro and vicinity, common (Arnold, 1903).

Pleistocene: Lower and upper San Pedro series of San Pedro and vicinity, rarer than in the Pliocene, Los Angeles County (Arnold, 1903).

Recent: Santa Barbara, California, to Salina Cruz, Mexico (Dall, 1921).

This species has rather flat whorls sculptured by a few spiral cords which are variable in their strength and disposition. The apical angle is greater than that of *cooperi* and the suture is very little or not at all depressed, sometimes rather indistinct. A common variant in the Pleistocene has two rather prominent spiral bands on each whorl, one adjacent to each suture. Some specimens show a minute nodosity on one or more of the spiral cords. Fine spiral threads are sometimes present just above the suture. A description of the many slight variations of sculpture would be useless, since they appear to occur sporadically, so far as we have observed in a brief study, and cannot be correlated with stratigraphic or geographic occurrence.

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[1] Mr. Charles Merriam at the University of California is making a study of the Turritellas, and in view of the forthcoming publication of his results, it is unnecessary to discuss the genus further here.

Turritella jewettii does not appear to intergrade with *T. cooperi* in the Pliocene, but probably descended from a common prototype earlier than the upper Miocene. Its ancestor is *Turritella freya* Nomland, a strikingly similar form in the upper Miocene.

T. jewettii is much less common as a fossil than *T. cooperi*.

Turritella jewettii Carpenter subspecies **freya** Nomland

Turritella freya Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 312, pl. 19, fig. 2, 1917.

Type specimen: In the collection at the University of California, No. 11,313.

Type locality: Coalinga district, California; U. Miocene.

"Shell tapering rapidly, number of whorls unknown; with distinct, slightly impressed suture. Whorls flat with a wide ridge near middle; immediately above the suture are two prominent spiral cords with interspaces of about the same width; between the middle ridge and suture above, a slight tendency to depression is noticeable; ridges and interspaces covered by numerous, on the type twenty-five, narrow spiral striations; incremental lines indistinct. Aperture subcircular to nearly square. Dimensions: Maximum diameter, 16 mm.; height unknown."

Miocene: Upper Miocene (Santa Margarita formation) of Coalinga district; also in type section of the Santa Margarita formation about a half mile north of the town of Santa Margarita, San Luis Obispo County, California.

This *Turritella* is so close to *T. jewettii* Carpenter that it can scarcely be regarded as more than a subspecies of the previously named form. The apical angle is identical with that of *jewettii* and the sculpture is similar to the sculpture of many Pleistocene specimens of Carpenter's typical form, except that *freya* appears to have numerous fine spiral threads, whereas typical *jewettii* has either very few or none.

Nomland also described *Turritella margaritana* from the Santa Margarita formation, but the type specimen is so poorly preserved that little can be determined in regard to its relationships.

Turritella cooperi Carpenter

Plate 24, Figures 28-34

Turritella cooperi Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 612, 655, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 216, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 80, 1868-9; Tryon, Man. Conch., Ser. 1, Vol. 7, p. 200, pl. 61, fig. 61, 1886; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 269, 1888; Keep, West Coast Shells, p. 73, fig. 58, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 205, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 318, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 300, 1903; Keep, West American Shells, p. 215, fig. 231, 1904; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 546, pl. 51, fig. 14, 1907; Bull. 309, U. S. Geol. Surv., pl. 41, fig. 14, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914; Dall, Bull. 112, U. S. Nat. Mus., p. 152, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 11, p. 16, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 55, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Turritella cooperi Carpenter var. *fernandoensis* Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 538, pl. 51, fig. 13, 1907; Bull. 309, U. S. Geol. Surv., pl. 41, fig. 13, 1907.

Turritella nova Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 208, pl. 11, fig. 3, 1916.

Shell with high, many-whorled spire; suture depressed; whorls somewhat ventricose, with spiral ridges or cords which vary widely in number and character, frequently consisting of two rather prominent carina which trisect the area of the whorl. Large Pleistocene specimens measure 65 mm. in length, with the body whorl 17 mm. in diameter.

Type specimens: Of *cooperi*, in the collection at the University of California, *fide* Oldroyd, 1927; of *fernandoensis*, in the U. S. National Museum, No. 164,957; of *nova*, in the collection at the University of California.

Type localities: Of *cooperi*, San Pedro, California, Recent, *fide* Oldroyd, 1927; of *fernandoensis*, Elsmere Canyon, Los Angeles County, lower Pliocene; of *nova*, Waltham Canyon, Fresno County, Pliocene.

Pliocene: S. D. S. N. H. localities 201, 203, 204, 206, 208, 215, 216, lower Pliocene of Elsmere Canyon and east of Fernando Pass, Los Angeles County (coll. by H. R. Gale); "Lower Fernando" of Elsmere, Holser, and Pico canyons, Los Angeles County (English, 1914); San Diego well, Balboa Park, San Diego (Dall); "Russ School" San Diego (Arnold, 1903); S. D. S. N. H. localities 213, 214, middle Pliocene west of Fernando Pass, Los Angeles County (coll. by H. R. Gale); S. D. S. N. H. localities 217, 217*a*, 217*b*, middle Pliocene of Holser Canyon, Los Angeles County, common (H. R. Gale, coll.); upper Pliocene north of city of Ventura (Waterfall, 1929); S. D. S. N. H. loc. 151, one and a half miles northeast of Goleta, upper Pliocene ?, Santa Barbara County (Van Court Warren).

Pleistocene: "Pliocene" of Deadman Island and lower San Pedro series of Deadman Island and San Pedro bluffs, Los Angeles County (Arnold, 1903); lower San Pedro fauna of Nob Hill cut, at San Pedro (Oldroyd, 1925); Pleistocene of Barlow's Ranch and the irrigation ditch north of Ventura, Ventura County (Arnold); S. D. S. N. H. loc. 233, Las Posas zone north of Arroyo Santa Rosa, Ventura County, common (U. S. G., coll.); S. D. S. N. H. loc. 244, lower part of the Las Posas zone in Sexton Canyon, Ventura County, not common (U. S. G., coll.); lower Quaternary at Magdalena Bay, Lower California, Mexico (E. K. Jordan, 1924); upper San Pedro series (Palos Verdes formation) of Crawfish George's, Los Cerritos, Lumber Yard, and Deadman Island (Arnold, 1903); Pleistocene of Pacific Beach, San Diego County (Arnold, 1903); San Quintin Bay, Lower California, Mexico (Dall, 1892).

Recent: Monterey to San Diego, California (Dall, 1921).

This species occurs at a considerable number of localities, sometimes in great abundance, only a few of the localities being recorded in the list given above. In the Recent fauna live specimens are seldom collected.

The most common Pleistocene form of this species has two carinæ on each whorl, which divide the side of the whorl into three parts. Sometimes these carinæ are slightly nodulose; sometimes interribs appear in more or less prominence; and other combinations of characters occur, which in isolated specimens appear to indicate varietal differences, but which are clearly only individual idiosyncrasies. In the middle and lower Pliocene these variants from the common Pleistocene form become more common but occur along with the typical form. The form having two or three interribs equal in strength to the two main carinæ Arnold named variety *fernandoensis*, while the form with the two carinæ well developed and separated by a narrow groove has been named *nova*. The characters upon which these names have been founded appear to intergrade and intermingle at several different localities and horizons and do not appear to warrant varietal distinctions.

Turritella mariana Dall,[1] a very slender shell described from west Mexican waters, appears to be closely related. We have not seen Dall's type, but specimens of *cooperi* from the lower Pliocene east of Fernando Pass (S. D. S. N. H. loc. 216) appear to agree rather closely with Dall's figure and description. *Turritella vanvlecki* Arnold appears to be closely related but distinct. It is characterized by having several spiral threads on the whorls and a carina-like spiral in about the middle of the whorl. This form occurs with *cooperi* in the middle Pliocene of Holser Canyon, but the two forms do not seem to intergrade.

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[1] Bull. Mus. Comp. Zool. Harvard College, Vol. 43, no. 6, p. 327, pl. 11, fig. 14, October, 1908; type locality, near Tres Marias Islands, Mexico, Recent, in 80 fathoms, rocky bottom.

Turritella vanvlecki Arnold

Plate 24, Figure 22

Turritella vanvlecki Arnold, U. S. Geol. Surv., Bull. 396, p. 85, pl. 22, fig. 3, January 15, 1910; Bull. 398, pl. 44, fig. 3, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, pl. 12, fig. 5, 1917.

Type specimen: In the U. S. National Museum, No. 165,496.

Type locality: Anticline Ridge, northeast of Coalinga, California; lower Pliocene.

Pliocene: Anticline Ridge, northeast of Coalinga; three miles north of Bradley, Monterey County; "near the base of the Etchegoin formation" (Arnold, 1910); Etchegoin Pliocene of Coalinga district (Nomland, 1917); S. D. S. N. H. localities 217*a*, 217*b*, middle Pliocene of Holser Canyon, Los Angeles County, five specimens (H. R. Gale, coll.).

The general appearance of this species is much like that of *T. cooperi* Carpenter, but typically the sculpture consists of five spiral ribs, with smaller interribs between, the middle primary being accentuated and carina-like. The suture is deeply impressed. The specimen herewith figured, however, has the basal spiral also accentuated, and the suture not impressed below the inward slope of the upper part of the whorl. While *Turritella cooperi* in the Pliocene has considerable variations in sculpture, its two carina-like ribs equidistant from the center of the whorl are generally well developed (attaining their greatest prominence in the form *nova* of Nomland and perhaps also in *mariana* Dall), whereas *vanvlecki* has one accentuated spiral riblet that occurs approximately in the middle of the whorl. In the form *fernandoensis* Arnold, the spiral riblets are small and all approximately of equal size. In the collections available for study we have seen no specimens intermediate between *cooperi* and *vanvlecki*, and consequently we have considered the latter specifically distinct. More material, however, may show it to be but a variety.

Turritella vanvlecki Arnold is placed in the section *Haustator* tentatively, since none of the specimens examined show the growth lines with sufficient clearness to determine the sectional characters. If the species is as closely related to *T. cooperi* as specimens at hand seem to indicate, it should unquestionably be placed in that section.

Section UNDETERMINED

The following species are not allocated to any section in this paper because their sectional characters have not been sufficiently studied.

Turritella goniostoma Valenciennes

Turritella goniostoma Valenciennes, Humboldt and Bonpland's Voy. Reg. Equin. Nouv. Cont., Pt. 2, Zoologie, Vol. 2, liv. 14, p. 275, 1832; Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 10, *Turritella*, pp. 21, 22, pl. 10, figs. 1, 1844; Reeve, Conch. Icon., Vol. 5, *Turritella*, sp. 10, pl. 3, figs. 10*a*, 10*b*, 1849; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 198 (in part), pl. 60, fig. 51, pl. 61, figs. ? 54, 55, 1886; Stearns, Proc. U. S. Nat. Mus., Vol. 14, p. 326, 1891; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pt. 5, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Pliocene: Santa Anita Point, also Coronados Island and Carmen Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, and upper Quaternary at Scammons Lagoon, Lower California, Mexico (Jordan).

Recent: Scammons Lagoon, Lower California, Mexico (Hemphill coll.), to Peru.

A discussion of the synonymy of this species will not be attempted here. Most authors who have been in a position to know remark upon the variability; but until abundant material is critically compared with the types or original descriptions and figures of several closely related supposed species of the west Mexican waters, any conclusions in regard to synonymy are premature. The species has been well figured and described by Kiener, who states that Valenciennes described it from a young individual. Specimens from the Pleistocene of Magdalena Bay agree with Kiener's figures. A rather common form has flat whorls with an indistinct linear suture on the earlier whorls and the later whorls protruding somewhat near the deeply depressed suture. Numerous spiral threads with minute intercalated threadlets cover most of the surface of the whorls where erosion has not been too vigorous. This appears to be the common form in the Magdalena Bay Pleistocene and is not uncommon in the Recent fauna of Lower California.

Turritella tigrina Kiener

Turritella tigrina Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 10, *Turritella*, p. 29, pl. 4, figs. 2, 1844; Reeve, Conch. Icon., Vol. 5, *Turritella*, sp. 10, pl. 3, fig. 8, 1849; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 199, pl. 62, fig. 65, 1886.

Turritella cumingii Reeve, Conch. Icon., Vol. 5, sp. 13, pl. 4, fig. 13, 1849; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 199, pl. 62, fig. 66, 1886.

Pleistocene: Coast of Oaxaca, Mexico (coll. by R. H. Palmer).
Recent: Cedros Island (?), Lower California, Mexico, to Panama.

This species is rather high spired, of about twenty whorls, which are flat sided and obtusely angulated or carinated on the lower part just above the suture. The sculpture consists of about ten spiral cords, usually about eight above the carination, often alternating in strength and with intercalated threadlets. The color of Recent specimens is whitish with irregular patches of chestnut or chocolate color.

It has been suggested that this species is conspecific with *T. leucostoma* Valenciennes, described in 1832. *T. cumingii* Reeve appears to be a synonym.

Turritella imperialis Hanna

Turritella imperialis Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 457, pl. 21, figs. 1, 2, 3, 1926.

Type specimen: In the collection at the University of California.

Type locality: In a branch of Alverson Canyon, Coyote Mountain, Imperial County, California, Lower Pliocene.

This is a high-spired species with a depression at the suture and another in the middle of the whorl. This produces a sculpture consisting of two prominent spiral ribs, slightly noded in some specimens. This species has only been reported from the Imperial formation of Coyote Mountain, from which Hanna has recorded a number of specimens.

It appears, as pointed out by Hanna, that *T. imperialis* is related to certain Atlantic coast Turritellas. It is like *T. inezana* Conrad, of the lower Miocene of California, with the spiral ribs accentuated.[1]

Turritella nodulosa King and Broderip

Turritella nodulosa King and Broderip, Zool. Journ., Vol. 5, p. 347, 1832; Reeve, Conch. Icon., Vol. 5, *Turritella*, sp. 11, pl. 4, figs. 11*a-b*, 1849; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 202, pl. 63, figs. 78, 79, 80, 1886; Zetek, Mol. Repub. Panama, p. 31, 1918; Dall, Nautilus, Vol. 32, p. 24, 1918; not *T. nodulosa* von Muenster, Beitr. zur Petref., 1841.

Turritella papillosa Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 5, *Turritella*, p. 31, pl. 14, fig. 3, 1844; re-figured by Tryon, *op. cit.*, pl. 63, fig. 80.

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[1] Called to our attention by Mr. William Corey and Dr. W. P. Woodring.

Pleistocene: Magdalena Bay, Lower California, Mexico (Dall).
Recent: West Mexican coast to Panama.

This species is of medium size, forty or fifty millimeters in length, consisting of fourteen or fifteen whorls. A common form has a prominent nodose carina in the middle of the whorl with about nine spiral threads above and ten or eleven below. It has a second, usually much less prominent carina below, next to the suture, and some authors state that this carina becomes on some specimens of equal prominence to the upper one, causing an obtusely bicarinate whorl profile. Living specimens are light yellowish-brown with chestnut maculations.

According to Kiener's figure, *T. papillosa* appears to be a synonym.

A number of large Turritellas have been described from the Miocene formations of California and Lower California. *Turritella inezana* Conrad,[1] characteristic of the Vaqueros formation (lower Miocene of California), is probably an immigrant species, as it appears to have no direct ancestor in the earlier Tertiary of the region. It is a high-spired species with flat-sided whorls obtusely or obscurely carinated on each side of the suture. A form with the whorls convexly inflated Wiedey has named variety *pertumida*.[2] *Turritella ocoyana* Conrad,[3] of the Temblor fauna (lower middle Miocene) of California, belongs to the typical section of *Turritella*. It also is an immigrant, but is sectionally distinct from *inezana*. *Turritella ocoyana* appears to be quite variable in strength of spiral sculpture, grading from the acutely keeled forms, which were named *Turritella bösei* by Hertlein and Jordan,[4] to the ventricose, obscurely carinated forms named *T. wittichi* by the same authors. The former name is probably a synonym of *ocoyana*, while the latter represents a more extreme variant and might be retained in a varietal sense, its final disposition depending upon a study of large collections. Wiedey,[5] however, has considered *T. wittichi* a synonym of *ocoyana*. *T. temblorensis* Wiedey (1928) is another variety of *ocoyana*. In the Peruvian Miocene the *ocoyana* clan is represented by *Turritella abrupta* Spieker (*T. robusta* Grzybowski, 1899, not *T. robusta* Gabb, 1864, + *T. charana* Spieker, 1922, + *T. supraconcava* Hanna and Israelsky, 1925, + *T. robusta fredeai* Hodson, 1926), which is a larger and more coarsely sculptured form.[6]

Genus TURRITELLOPSIS G. O. Sars, 1878

Turritellopsis G. O. Sars, Moll. Reg. Arct. Norv., p. 186, 1878; Tryon; Man. Conch., Ser. 1, Vol. 8, p. 193, 1886.

Shell like that of *Turritella*, the whorls of the spire grooved across; aperture oval; radula without marginal teeth. Inhabits boreal seas. (Tryon.)

Type (by monotypy), *Turritelopsis acicula* (Stimpson), north Atlantic, Recent.

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[1] Pac. R. R. Repts., Vol. 7, p. 175, pl. 8, fig. 4, 1857. Santa Inez Mountains. Wiedey (Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 120, 121, 1928) discussed this species but believed *T. variata* Conrad occurred with it. Woodring (Trans. San Diego Soc. Nat. Hist., Vol. 6, p. 160-1930) concluded the latter species was of upper Eocene age.

[2] *Op. cit.* Vol. 5, no. 10, p. 119, pl. 12, figs. 1, 6, 1928.

[3] U. S. Pac. R. R. Repts., Vol. 5, p. 329, pl. 8, figs. 73, 73*a–b*, 1856; re-figured by Wiedey, *op. cit.*, pl. 10, figs. 2, 4, 9.

[4] Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 634, pl. 21, figs. 1, 2, 1927.

[5] Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 120, 1928.

[6] Woodring has recently given an excellent short discussion of the *ocoyana* "phylum" of Turritellas; *vide* Carnegie Inst., Publ. No. 385, pp. 95, 96 and footnote, 1928.

Turritellopsis acicula (Stimpson) variety **stimpsoni** Dall

"*Turritellopsis acicula* Stimpson" G. O. Sars, Moll. Reg. Arct. Norv., p. 186, pl. 10, figs. 14*a-b*, 1878; not *Turritella acicula* Stimpson, Shells of New England, p. 35, pl. 1, fig. 5, 1851.

Turritellopsis acicula stimpsoni Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 347, 1919; U. S. Nat. Mus., Bull. 112, p. 152, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 59, 1927.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Nunivak Island, Alaska, to San Diego, California, circumboreal (Dall, 1921).

Genus **TACHYRHYNCHUS** Mörch, 1868

Tachyrhynchus Mörch, Amer. Journ. Conch., Vol. 4, p. 46, June 4, 1868.

Tachyrhynchus lacteolus (Carpenter) variety **subplanatus** (Carpenter)

Mesalia subplanata Carpenter, Proc. Acad. Nat. Sci. Phila. for 1865, p. 62.

Tachyrhynchus lacteolus subplanatus Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 152, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 58, 1927.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Puget Sound to San Diego, California (Dall).

This shell looks like some species of *Bittium* but it is supposed to have a multispiral operculum with central nucleus, whereas *Bittium* has a paucispiral operculum.

Family VERMETIDAE

Shell tubular, septate within, attached or free; sometimes regularly spiral when young, always becoming irregular in adult growth; aperture rounded, usually entire, sometimes fissured; operculum corneous, annular, sometimes spiral, rarely absent. (Tryon.)

For discussions of the *Vermetidæ* the reader is referred to the review of the family by Mörch[1] and to the monograph by Tryon.[2]

Genus **VERMICULARIA** Lamarck, 1799

Vermicularia Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 78, 1799; Syst. Anim. s. Vert., p. 97, 1801; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 168, 1886.

Type (by monotypy), *Serpula lumbricalis* Linnæus, figured by Tryon, *op. cit.*, p. 186, pl. 55, fig. 98, 1886, Indo-Pacific, Recent.

Shell free, in its early stage regularly coiled like a *Turritella;* subsequently uncoiled, the tube variously twisted or more or less straight and prolonged; operculum size of the aperture. Tropical and subtropical. (Tryon.)

Vermicularia eburnea (Reeve)

Vermetus eburneus Reeve, Conch. Syst., Vol. 2, p. 46, pl. 152, fig. 2, 1842; Proc. Zool. Soc. London, Pt. 10, p. 197, February, 1843; Carpenter, Proc. Zool. Soc. London for 1863, p. 358, 1863; Brit. Assn. Adv. Sci., Rept. for 1863, p. 556, 1864.

"*Vermetus glomeratus* ? Lamarck," C. B. Adams, Ann. Lyc. Nat. Hist. New York, Vol. 5, p. 216 (of separate), 1852, not of Lamarck.

Vermetus (*Vermicularia*) *pellucidus* Broderip and Sowerby, var. *eburneus* Reeve, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 188, pl. 56, fig. 6, 1886.

Vermiculus fewkesi Yates, Santa Barbara Soc. Nat. Hist., Bull. No. 2, p. 48, pl. 2, figs. 8, 9, August, 1890.

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[1] Review of the *Vermetidæ*, Proc. Zool. Soc. London for 1861, pp. 145-181, pl. 25, and pp. 326-365, 1861.

[2] Man. Conch., Ser. 1, Vol. 8, 1886.

Vermicularia eburnea Reeve, Dall, U. S. Nat. Mus., Bull. 112, p. 150, 1921; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 460, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 49, 1927.

Type locality: South America (*fide* Oldroyd).

Pliocene: Coyote Mountain, Imperial County, California (Hanna).
Recent: San Pedro, California, to Panama (Dall); South America.

Vermicularia (?) nodosa (T. S. Oldroyd)

Vermetus nodosus T. S. Oldroyd, Nautilus, Vol. 34, p. 116, pl. 5, fig. 10, April, 1921.

Type specimen: In the Oldroyd Collection at Stanford University.

Type locality: Nob Hill cut, San Pedro, Pleistocene.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County (Oldroyd).

Oldroyd described this shell as follows:

> "Shell a fragment; length 46 mm.; breadth 11 mm.; smooth and perfectly round and curved, septate within. The specimen has three large pear-shaped nodes, two of which are opposite each other, over the septum, one lengthwise of the shell, and the other crosswise."

Genus ALETES Carpenter, 1856

Aletes Carpenter, Proc. Zool. Soc. London, Part 24, p. 226, 1856[1]; Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 301, 1855-57; Tryon, Man. Conch., Ser. 1, Vol. 8, pp. 165, 174, 1886.

Type (by monotypy), *Aletes squamigerus* Carpenter.

Shell spirally twisted, attached, surface often decussated, columella with a faint median thread-like line.

Aletes squamigerus Carpenter

Aletes squamigerus Carpenter, Proc. Zool. Soc. London for 1856, p. 226, 1856; Dall, U. S. Nat. Mus., Bull. 112, p. 151, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 49, 1927; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 253, 254, 255, 1929.
Vermetus (*Thylacodes*) *squamigerus* Carpenter, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 181, pl. 54, figs. 73, 74, 1886.
Serpulorbis squamigerus Carpenter, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 264, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 299, 1903.
Vermetus squamigerus Carpenter, E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919.

Type locality: Santa Barbara, California, Recent.

Pleistocene: Santa Barbara to San Diego (Cooper); rare in lower San Pedro series of Deadman Island and San Pedro; common in upper San Pedro series of San Pedro and vicinity (Arnold); chiton bed on Point Firmin, near San Pedro (Chace); palisades of Santa Monica (coll. of F. C. Clark); Pacific Beach, Point Loma, and two miles north of Del Mar, San Diego County (Stephens); San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California, to Payta, Peru, and the Galapagos Islands (Dall).

Aletes squamigerus Carpenter variety **pennatus** (Mörch)

Plate 24, Figure 5

Stephopoma pennatum Mörch, Journ. de Conchyl., Ser. 2, Vol. 4, p. 43, 1860; Proc. Zool. Soc. London for 1861, p. 151, pl. 25, figs. 3, 4, 5 (shell), 6, 7 (operculum), 8 (spine of operculum), 1861.
Aletes squamigerus pennatus Mörch, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925.

Pleistocene: Lower San Pedro of Nob Hill cut, San Pedro, Los Angeles County, "plentiful" (Oldroyd).
Recent: West coast of Mexico and Panama ?

This variety lacks the rough longitudinal striations of the typical form.

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[1] In the Zoological Society Proceedings for 1856, Carpenter refers to his Mazatlan Catalogue, p. 301, hence the latter must have been at least in page proof at that time. But since the title page gives the dates "1855-57," we have assumed for the time being that its actual date of issue was 1857.

Genus SPIROGLYPHUS Daudin, 1800

Spiroglyphus F. M. Daudin, Rec. Mém. Moll., p. 39, 1800; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 166, 1886.

Type, *Spiroglyphus annulatus* Daudin, 1800, figured by Tryon, *op. cit.*, p. 178, pl. 51, figs. 51, 52, 1886.

Animal excavating a groove on the surface of shells or stones, covering it over with shelly material, thus forming a tubular planorbiform case. When first hatched, the shell is spiral and regular, consisting of one and a half whorls. Operculum large, thick, convex exteriorly, with strong concentric laminæ, plane interiorly, concentrically lirate, with central mamilla, and narrowly elevated margin. (After Tryon.)

Spiroglyphus lituella (Mörch)

Siphonium (Dendropoma) lituella Mörch, Proc. Zool. Soc. London for 1861, p. 154, 1861.

Spiroglyphus lituella Mörch, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 654, 1864; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 299, 1903.

Vermetus (Siphonium) lituella Mörch, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 183, pl. 54, fig. 82, 1886.

Spiroglyphus lituellus Mörch, Dall, U. S. Nat. Mus., Bull. 112, p. 151, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 50, 1927.

Pleistocene: Upper San Pedro series of San Pedro, Deadman Island, Crawfish George's, and Los Cerritos, Los Angeles County, "common on stones and shells" (Arnold).
Recent: Forrester Island, Alaska, to San Diego, California (Dall).

Genus PETALOCONCHUS Lea, 1843

Petaloconchus H. C. Lea, Trans. Amer. Philos. Soc., New Series, Vol. 9, p. 233, 1843; Tryon, Man. Conch., Ser. 1, Vol. 8, pp. 165, 172, 1886; Woodring, Carnegie Inst., Publ. No. 385, p. 347, 1928.

Type (by monotypy), *Petaloconchus sculpturatus* Lea, figured by Tryon, Struct. Syst. Conch., pl. 67, fig. 76, 1883.

Shell more or less regularly coiled in an open spire during part of growth, more or less straight during final stage. Early stage contorted or more regularly coiled. Aperture circular. Columellar wall bearing two relatively long, thin lamellæ that disappear near aperture and may be absent elsewhere. Sculpture consisting of spirally arranged crude pustules or of axial ribs. (Woodring.)

Petaloconchus anellum (Mörch)

Vermetus anellum Mörch, Proc. Zool. Soc. London for 1861, p. 359.

Vermetus (Petaloconchus) anellum Mörch, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 173, pl. 49, fig. 34, 1886.

Vermiculum anellum Mörch, Dall, U. S. Nat. Mus., Bull. 112, p. 151, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Petaloconchus anellum Mörch, Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 51, 1927.

Type locality: California, on *Haliotis.*

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California, to Todos Santos Bay, Lower California, Mexico (Dall).

Petaloconchus complicatus Dall

Petaloconchus complicatus Dall, Bull. Mus. Comp. Zool. Harvard Coll., Vol. 43, p. 326, 1908; U. S. Nat. Mus., Bull. 112, p. 151, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 3, Pt. 3, p. 52, 1927.

Type specimen: In the U. S. National Museum, No. 123,035.

Type locality: Near Cocos Island, Recent.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Puget Sound to Panama (Dall, 1921).

Family CAECIDAE

Bartsch[1] has proposed the following artificial key to the genera of the Family *Cæcidæ:*

- Operculum conic.. *Brochina*
- Operculum flat or concave
  - Sculpture absent excepting incremental lines........................ *Fartulum*
  - Sculpture not absent
    - Sculpture of raised spiral ridges only........................ *Elephantulum*
    - Sculpture not of raised spiral ridges only
      - Sculpture of raised spiral ridges and axial rings............ *Elephantanellum*
      - Sculpture of axial rings only
        - Axial rings strong and distantly spaced........................ *Cæcum*
        - Axial rings slender and closely spaced..................... *Micranellum*

It should be noted that the axial sculpture parallels the aperture.

Genus CAECUM Fleming, 1817

Cæcum californicum Dall

Cæcum cooperi Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864, not *Cæcum cooperi* Smith, Ann. Lyc. Nat. Hist. N. Y. for 1862, pp. 154, 168.

Cæcum californicum Dall, Proc. U. S. Nat. Mus., Vol. 8, p. 541, 1885; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 219, pl. 66, fig. 65, 1886; Baker, Nautilus, Vol. 16, p. 41, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 297, pl. 8, fig. 6, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 149, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro (Arnold) and of Nob Hill cut at San Pedro (T. S. Oldroyd); upper San Pedro series of San Pedro and Crawfish George's, "quite common" (Arnold); San Diego (Stearns, *fide* Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to Lower California (Dall); San Martin Island, Lower California, Mexico (Baker).

Cæcum dalli Bartsch

Cæcum dalli Bartsch, Journ. Wash. Acad. Sci., Vol. 10, p. 568, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 149, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: San Pedro, California, to Lower California, Mexico (Dall).

Genus MICRANELLUM Bartsch, 1920

Micranellum Bartsch, Journ. Wash. Acad. Sci., Vol. 10, p. 568, December 4, 1920.

Type (by original designation), *Cæcum crebricinctum* Carpenter.

Surface of the shell marked by closely spaced, slender, axial annulations; operculum thin, corneous, concave. (Bartsch.)

Micranellum crebricinctum (Carpenter)

Cæcum crebricinctum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 655, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 215, 1865; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 218, pl. 67, fig. 71, 1886; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 300, 1892; Baker, Nautilus, Vol. 16, p. 41, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 298, 1903.

Micranellum crebricinctum Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 149, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 45, 1927.

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[1] Journ. Wash. Acad. Sci., Vol. 10, p. 566, 1920.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro (Arnold) and "plentiful" at Nob Hill cut, San Pedro (T. S. Oldroyd); upper San Pedro series at San Pedro and Crawfish George's, Los Angeles County (Arnold); Coronado Beach, San Diego (Dall, 1892); upper Pleistocene at San Quentin Bay, Lower California, Mexico (Jordan; Dall, 1892, record attributed to Orcutt, and age given as Pliocene).
Recent: Monterey, California, to Todos Santos Bay, Lower California, Mexico (Dall, 1921); San Martin Island, Lower California (Baker).

According to Dall (1892), *Cæcum magnum* Stearns[1] is a synonym. *M. crebricinctum* is a shallow-water shell, locally quite abundant.

Micranellum pedroënse Bartsch

Micranellum pedroënse Bartsch, Journ. Wash. Acad. Sci., Vol. 10, p. 564, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 149, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 46, 1927.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro to San Diego, California (Dall).

Genus FARTULUM Carpenter, 1858

Fartulum bakeri Bartsch

Fartulum bakeri Bartsch, Journ. Wash. Acad. Sci., Vol. 10, p. 566, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 150, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Ellamar, Alaska, to Mazatlan, Mexico (Dall).

Fartulum hemphilli Bartsch

Fartulum hemphilli Bartsch, Journ. Wash. Acad. Sci., Vol. 10, p. 566, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 150, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 16, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, "not rare" (T. S. Oldroyd); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro, California, to Point Abreojos, Lower California, Mexico (Jordan).

Fartulum occidentale Bartsch

Fartulum occidentale Bartsch, Journ. Wash. Acad. Sci., Vol. 10, p. 566, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 150, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Gulf of Georgia to Lower California (Dall).

Family LITTORINIDAE

Genus LITTORINA Ferrusac, 1822

Littorina Ferrusac, Tabl. Syst., pp. xi, xxxiv, 1822; Rang, Man. Mollusques, p. 185, 1829; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 79, 1909; Iredale, Proc. Malac. Soc. London, Vol. 10, p. 223, 1912.

Type (by subsequent designation, Rang, 1829, *fide* Dall and Iredale), *Littorina littoralis.*

As the species of this genus are very variable, it is probable that the number of names listed below should be reduced materially by synonymizing some of those more recently proposed.

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[1] See Tryon, Man. Conch., Ser. 1, Vol. 8, p. 219, pl. 67, fig. 83, 1886.

Littorina mariana Arnold

Littorina mariana Arnold, U. S. Geol. Surv., Bull. 396, p. 86, pl. 29, fig. 1, 1910; Bull. 398, pl. 51, same figure, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917.

Pliocene: Upper *Mya* horizon, upper part of Etchegoin formation, Coalinga district, San Joaquin basin, upper Pliocene (Arnold; Nomland).

Littorina mariana Arnold variety **alta** Arnold

Littarina mariana var. *alta* Arnold, *op. cit.*, p. 87, pl. 29, fig. 2, 1910; Bull. 398, pl. 51, fig. 2, 1910; Nomland, *op. cit.*, p. 221, 1917.

Pliocene: With the typical variety (Arnold; Nomland).

This may be only an individual variation of the shorter spired typical form.

Littorina palliata (Say)

Turbo palliatus Say, Journ. Acad. Nat. Sci. Phila., Vol. 2, p. 240, 1822.
Littorina palliata Say, Gould, Inv. Mass., p. 260, fig. 167, 1841; Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 29, pl. 5, fig. 12, 1920; U. S. Nat. Mus., Bull. 112, p. 152, 1921.

Pliocene: Prospectors' pits on the second beach, one-half to one-fourth mile east of Nome, Alaska (Dall, 1920).
Recent: Atlantic (Dall, 1921).

Littorina petricola Dall

Littorina petricola Dall, U. S. Geol. Surv., Prof. Paper 59, p. 80, pl. 4, fig. 9, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 594, 1913; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93, and table opposite, 1922.

Miocene: Questionably in the Empire formation, upper Miocene of Coos Bay, Oregon (Howe).
Pliocene: Coos conglomerate of Fossil Rock, Coos Bay, Oregon (Dall, as Pleistocene; Howe); four miles south of Empire, Oregon (Arnold and Hannibal).

Littorina remondi Gabb

Littorina remondi Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 14, pl. 2, figs. 23, 23*a*, 1866, p. 80, 1868-9; Weaver, Univ. Calif. Publ. Geol., Vol. 5, p. 254, 1909; Clark, in Lawson, U. S. Geol. Surv., Folio No. 193, p. 12, 1914; Clark, Univ. Calif. Publ. Geol., Vol. 8, pp. 403, 405, 422, 425, 484, 560, pl. 65, fig. 13, 1915; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 346, pl. 32, fig. 5, 1927.

Miocene: Kirker's Pass, Contra Costa County (Gabb, as Pliocene); San Pablo formation, upper Miocene, middle California (Clark).

Littorina planaxis Nuttall in Philippi

Littorina planaxis Nuttall, Philippi, Abbild. Beschr. Conchyl., Vol. 2, pt. 7, p. 201, pl. 4, fig. 16, March, 1847; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 80, 1868-9; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 248, pl. 43, fig. 55, 1887; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 246, 1888; Keep, West Coast Shells, p. 68, fig. 53, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 301, 1903; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919.
Littorina patula Gould, Otia Conch., "Expedition Shells," p. 52, 1846.
Littorina planaxis Philippi, Dall, U. S. Nat. Mus., Bull. 112, p. 153, 1921, "*Litorina*" in error; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1925.

Pleistocene: "Pliocene" of Deadman Island, Timms Point zone; lower San Pedro series at Deadman Island and San Pedro (Arnold); lower San Pedro series at Nob Hill cut (T. S. Oldroyd); upper San Pedro series at San Pedro (Arnold); chiton bed at Point Firmin (Chace); palisades of Santa Monica (coll. of F. C. Clark); San Nicholas Island; San Diego (Cooper).
Recent: Puget Sound to Magdalena Bay, Guadalupe and Socorro islands, Mexico (Dall).

Philippi attributed this species to Nuttall with a query as to its place of publication. His description of the species appears to be the first, and to avoid confusion the name should be cited as Nuttall in Philippi.

Littorina scutulata Gould

Plate 32, Figures 16, 17, 18

Littorina scutulata Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 83, 1849; U. S. Expl. Exped., Vol. 12, p. 200, 1852, Moll. Atlas, pl. 14, figs. 241, 241*a*, 1856; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 250, pl. 45, figs. 98, 99, 100, 1887; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 246, 1888; Keep, West Coast Shells, p. 68, fig. 52, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 302, 1903; E. P. and E. M. Chace, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Littorina (*Melarhape*) *scutulata* Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 153, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1922.

Type locality: Puget Sound, Recent.

Pleistocene: Lower San Pedro series of Deadman Island, San Pedro (Arnold); Nob Hill cut (Oldroyd): Barlow's Ranch, near Ventura (Arnold); chiton bed at Point Firmin (Chace); Pacific Beach and Spanish Bight, San Diego (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Kodiak Island, Alaska, to Turtle Bay and Socorro Island, Lower California, Mexico (Dall).

L. lapida and *plena* Gould, 1849, are both synonyms.

Littorina varia Sowerby

Littorina varia Sowerby, Genera Shells, *Littorina*, No. 38, fig. 3, 1832; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 246, pl. 43, fig. 44, 1887; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 231, 1909; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 156, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 449, 1926.

Pliocene: Coyote Mountain, Imperial County (Hanna).

Recent: Magdalena Bay, Lower California, Mexico, to Casma, Peru (Jordan).

Family LACUNIDAE

Genus LACUNA Turton, 1827

It is possible that there is but one, very variable species in this genus in the California fauna.

Lacuna divaricata (Fabricius) variety **solidula** Lovén

Plate 32, Figure 19

Lacuna solidula Lovén, Index Moll. Scandinavia, p. 23, 1846; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 266 in part, pl. 50, fig. 69, 1887; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 244, 1888; Dall, U. S. Nat. Mus., Bull. 112, p. 154, 1921; Strong, Nautilus, Vol. 38, p. 16, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1925.

Littorina pedroana Conrad, U. S. Pacific R. R. Repts., Vol. 5, p. 327, pl. 6, fig. 50, 1856.

Lacuna solidula (Lovén) Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 303, pl. 8, fig. 11, 1903.

Pleistocene: Santa Barbara to San Diego (Cooper); "rare in lower San Pedro series at Deadman Island and upper San Pedro series at San Pedro," also at Pacific Beach, San Diego (Arnold); lower San Pedro at Nob Hill cut, San Pedro (T. S. Oldroyd); palisades of Santa Monica (coll. of F. C. Clark).

Recent: Puget Sound, Washington, to San Diego, California; also Atlantic (Dall).

Lacuna divaricata (Fabricius) variety **carinata** Gould

Lacuna carinata Gould, Otia Conch., "Expedition Shells," p. 52, 1846; Proc. Boston Soc. Nat. Hist., Vol. 3, p. 75, 1848; U. S. Expl. Exped., Vol. 12, p. 194, 1852, Moll. Atlas, pl. 14, figs. 230, 230*a*, 230*b*, 1856; Tryon, Man. Conch., Ser. 1, Vol. 9, pl. 50, figs. 71, 72, 1887.

Lacuna ? var. *compacta* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 656, 1864.

Lacuna (? *solidula*, var.) *compacta* Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 429, 1864.

Lacuna compacta Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 302, 1903; U. S. Geol. Surv., Bull. 321, p. 74, pl. 11, fig. 2, 1907; Berry, Nautilus, Vol. 22, p. 38, 1908.

Lacuna solidula var. *carinata* Gould, Strong, Nautilus, Vol. 38, p. 17, 1924.

Pliocene: Uppermost Pliocene at Bath-house Beach, Santa Barbara (Arnold, 1907, as *L. compacta* Carpenter).
Pleistocene: Rare in lower San Pedro series at Deadman Island; upper San Pedro series at Los Cerritos and San Pedro; Barlow's Ranch, near Ventura; Spanish Bight, San Diego (Arnold).
Recent: Vancouver, British Columbia, south possibly to Orange County, California (Strong).

Lacuna unifasciata Carpenter

Lacuna unifasciata Carpenter, Proc. Zool. Soc. London for 1856, p. 205; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 267, pl. 50, figs. 63, 74, 1887; Baker, Nautilus, Vol. 16, p. 41, 1902; Dall, U. S. Nat. Mus., Bull. 112, p. 154, 1921; Strong, Nautilus, Vol. 38, p. 17, 1924; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 251, 1929.

Pleistocene: "Saugus" formation near Ventura (Waterfall); palisades north of Santa Monica, Los Angeles County (coll. of F. C. Clark); foot of Twenty-sixth Street, San Diego (F. Stephens); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Barbara, California, to Magdalena Bay, Lower California, Mexico (Dall).

Lacuna unifasciata Carpenter variety **aurantiaca** Carpenter

Lacuna unifasciata Carpenter, var. *aurantiaca* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 656, 1864; Dall, U. S. Nat. Mus., Bull. 112, p. 154, 1921; Strong, Nautilus, Vol. 38, p. 17, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, "not rare" (T. S. Oldroyd).
Recent: Santa Barbara, California, to Point Abreojos, Lower California, Mexico (Dall).

Lacuna porrecta Carpenter

Lacuna porrecta Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 656, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 429, 1864; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 265, pl. 50, figs. 55, 56, 57, 1887; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 303, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 154, 1921; Strong, Nautilus, Vol. 38, p. 17, 1924.

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro; upper series at Deadman Island, San Pedro, Los Cerritos, and Crawfish George's (Arnold); all Los Angeles County.
Recent: Commander Islands, Bering Sea, southward and eastward to San Diego, California (Dall).

Family FOSSARIDAE

Genus ISELICA Dall, 1918

Isapis H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 320, pl. 33, fig. 8, February, 1854, not *Isapis* Westwood, 1851.
Iselica Dall, Proc. Biol. Soc. Washington, Vol. 31, p. 137, 1918, new name for *Isapis* H. and A. Adams, 1854, not Westwood, 1851.

Type (by monotypy), *Isapis anomala* C. B. Adams, figured by H. and A. Adams, *op. cit.*, pl. 33, fig. 8, 1854.

Iselica fenestrata (Carpenter)

Isapis fenestrata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 628, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 429, December, 1864.
Fossarus (Isapis) fenestrata Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 304, 1903.
Iselica fenestrata Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 155, pl. 13, fig. 2, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1925.

Pleistocene: Lower San Pedro series of Deadman Island, San Pedro (Arnold), and Nob Hill cut (Oldroyd); upper San Pedro series at Crawfish George's, San Pedro, and Deadman Island (Arnold); all in Los Angeles County.
Recent: Puget Sound, British Columbia, to Gulf of California, Mexico (Dall).

Family LITIOPIDAE

Genus ALABA H. and A. Adams, 1853

Alaba H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 241, 1853; Nevill, Hand List Moll. Indian Mus., Pt. 2, p. 181, 1885; Woodring, Carnegie Inst., Publ. No. 385, p. 340, 1928.

Type (by subsequent designation, Nevill, 1885, *fide* Woodring), *Alaba melanura* (C. B. Adams).

Alaba jeannettæ Bartsch

Alaba jeannettæ Bartsch, Proc. U. S. Nat. Mus., Vol. 39, p. 155, text figs. 3, 4, 1910.
Alaba jeanette Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 155, 1921; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Type locality: Margarita Bay, Lower California, Mexico, Recent.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro, California, to Gulf of California (Dall).

Alaba catalinensis Bartsch

Alaba catalinensis Bartsch, Journ. Wash. Acad. Sci., Vol. 10, p. 572, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 156, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Catalina Island, California.

Family ?

Genus DIALA A. Adams, 1861

Diala acuta Carpenter

Diala acuta Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 657, 1864; Dall, U. S. Nat. Mus., Bull. 112, p. 156, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 17, 1925.

Pleistocene: Lower San Pedro series at Nob Hill cut, San Pedro, Los Angeles County (Oldroyd).
Recent: Monterey, California, to Coronado Islands, Lower California, Mexico (Dall).

For a figure of this species Dall (1921) refers questionably to Tryon's figure of *Litiopa leithi* Smith (Man. Conch., Ser. 1, Vol. 9, pl. 53, fig. 86, 1887).

Diala marmorea Carpenter

Diala marmorea Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 657, 1864; Baker, Nautilus, Vol. 16, p. 41, 1902; Berry, Vol. 22, p. 38, 1908; Dall, U. S. Nat. Mus., Bull. 112, p. 156, 1921.
Litiopa (*Diala*) *marmorea* Carpenter, Tryon, Man. Conch., Ser. 1, Vol. 9, p. 283, pl. 53, fig. 87, 1887.

Pliocene: Uppermost Pliocene at Bath-house Beach, Santa Barbara (Berry).
Recent: Queen Charlotte Islands, British Columbia, to San Martin Island, Lower California, Mexico (Baker).

This and the preceding species may belong to *Barleeia* Clark.

Genus BARLEEIA Clark, 1855

Barleeia Clark, Brit. Marine Test. Moll., pp. 392-395, 1855; Bartsch, Proc. U. S. Nat. Mus., Vol. 58, p. 166, 1920.

Type (*fide* Bartsch), *Barleeia rubra* (Montagu).

Barleeia bentleyi Bartsch

Barleeia bentleyi Bartsch, Proc. U. S. Nat. Mus., Vol. 58, p. 168, pl. 13, fig. 2, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 156, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Venice, California (Bartsch).

Barleeia dalli Bartsch

Barleeia dalli Bartsch, Proc. U. S. Nat. Mus., Vol. 58, p. 168, pl. 13, fig. 10, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 156, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Off Point Loma, California, in 71 to 75 fathoms on sand and mud bottom (Bartsch).

This and the preceding species differ from the other west American forms in having the periphery of the last whorl acutely carinated.

Family ARCHITECTONICIDAE

Genus ARCHITECTONICA Bolten, 1798

Architectonica Bolten, Mus. Boltenianum, p. 78, 1798; Woodring, Carnegie Inst., Publ. No. 385, p. 354, 1928.
Solarium Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 74, 1799, only species, *Trochus perspectivus* Linnæus; Sowerby, Gen. Rec. Foss. Shells, pl. 202 and text, 1820-25; Tryon, Struct. Syst. Conch., Pt. 2, p. 217, 1883; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 323, 1892.
Architectoma Gray, Proc. Zool. Soc. London, Pt. 15, p. 151, 1847, *err. pro Architectonica* Bolten.

Type (by subsequent designation, Gray, 1847), *Trochus perspectivus* Linnæus, Indo-Pacific, Recent.

Shell low, conical, with several regularly enlarging, tightly coiled whorls, basal margin of shell subangular; aperture subtrapezoidal, outer lip simple; umbilicus open, often wide, with margins crenulated; operculum horny, subspiral.

Torinia Gray has a calcareous operculum. *Climacopoma* Fischer[1] appears to have the peculiar spiral calcareous operculum of *Torinia* but the shell of *Architectonica, sensu stricto.* *Spirolaxis* Monterosato[2] is a distinct genus of partly uncoiled shells with an anastrophic nucleus. *Pseudomalaxis* Fischer[3] is dorsally flat and deeply concave ventrally. The following species is a typical *Architectonica.*

Architectonica nobilis Bolten

Architectonica nobilis Bolten, Mus. Boltenianum, p. 78, 1798; Woodring, Carnegie Inst., Publ. No. 385, p. 355, 1928.
Solarium granulatum Lamarck, Hist. Anim. s. Vert., Vol. 7, p. 3, 1822; Desh. and M. Edw. Ed., Vol. 9, p. 98, 1843; Carpenter, Proc. Zool. Soc. London for 1863, p. 355, 1863; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 529, 538, 541, 550, 572, 624, 667, 1864; reprinted in Smithsonian Misc. Coll., No. 252, 1872; Reeve, Conch. Icon., Vol. 15, *Solarium*, pl. 2, fig. 7, 1864; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 11, pl. 5, figs. 53, 54, 1887; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 329 in part, 1892; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 58, 1895.
Solarium quadriceps Hinds, Proc. Zool. Soc. London for 1844, p. 23, 1844; Carpenter, Proc. Zool. Soc. London for 1863, p. 355, 1863; Brit. Assn. Adv. Sci., Rept. for 1863, pp. 529, 541, 572, 624, 667, 1864; Reeve, Conch. Icon., Vol. 15, *Solarium*, pl. 3, figs. 18*a*, 18*b*, 1864; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 10, pl. 4, figs. 39, 40, 1887; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 58, 1895.

Recent: Lower California, Mexico, to Panama; also from Cape Hatteras to the Gulf of Mexico and the West Indies.

Architectonica nobilis Bolten appears to be an earlier name for *Solarium granulatum* Lamarck. Unfortunately Lamarck did not state the habitat[4] of his species and Hinds (1844), for some unknown reason, assumed that *granulata* was an Asiatic shell and redescribed what is almost certainly the Pacific *granulata* as *quadriceps*, giving the type locality as "Bay of Panama, in five fathoms, among mud." Carpenter, who was an experienced and skillful conchologist, as well as an early student of Pacific coast mollusca, believed that the Pacific shell which Hinds named *quadriceps* was not distinguishable from the Gulf of Mexico *granulata.* In 1863 he stated: "I know of no mark by which to distinguish the shells of the two oceans. From each locality they vary greatly in the size of the umbilicus, and in the strength of sculpture, number of knobs, etc. I should consider them all as varieties of *S. granulatum* Lam. *S. quadriceps* Hds., appears distinct, though it may only be an extreme variety." In his report published a year later (1864) he remarked: "On comparing suites of *S. granulosum* [*sic.*] from the Texan coast with series from the Gulf of California, it appeared that on each side of the Peninsula the shells went through similar changes in strength of sculpture, size of umbilicus, number of spiral granules, etc.; nor could any clue be obtained by which the coasts could be separated in a mixed collection. Hinds's shell stands the furthest extreme of removal from *S. granulatum*" (p. 529).

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[1] Man. Conchyl., p. 714, 1885, monotype, *Solarium patulum* Lamarck. Dall's *Patulaxis* may be a synonym.

[2] Proc. Malac. Soc. London, Vol. 10, p. 363, 1913, monotype, *Pseudomalaxis centrifuga* Monterosato, Mediterranean Sea, Recent.

[3] Man. Conchyl., p. 714, 1885, monotype, *Bifrontia ? zanclea* Philippi, Sicilian Pliocene. See discussions by Iredale, Proc. Malac. Soc. London, Vol. 9, pp. 253-257, 1911, and by Woodring, Carnegie Inst., Publ. No. 385, p. 359, 1928.

[4] Dall (1892) and Woodring (1928) have considered *granulata* Lamarck, a synonym of *nobilis* Bolten, a Gulf of Mexico species. Lacking evidence to the contrary, it seems more probable that Lamarck's specimen came from the Atlantic than from the Pacific, for in Lamarck's time the Atlantic was better known conchologically. Lamarck's description fits the shell commonly known as *granulatum*.

The present authors have had but a very small series of shells from the two oceans to compare; but with these few, considering Hinds' assumption of the Asiatic habitat of *granulata* erroneous, and relying on Carpenter's published remarks, they believe that the Pacific shells, from the northern part of the range at least, are not even varietally distinct from the typical Texan specimens of *granulata* (= *A. nobilis* Bolten), and that Hinds' *quadriceps* of Panama is either a close synonym or a very unimportant southern variety or geographic race.

Architectonica nobilis Bolten variety **discus,** new variety

Plate 32, Figure 27

"*Solarium quadriceps* Hinds," Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 442, 1926.

"*Architectonica granulata* Sowerby," Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Shell like that of the typical variety but with a sharper basal periphery. Dimensions: Altitude from apex to rim of umbilicus opposite aperture, 7.5 mm.; altitude from apex to lower edge of aperture, 11.1 mm.; diameter, 20.5 mm.

Type specimen: No. 308, in the collection of the San Diego Society of Natural History.

Type locality: About one mile southwest of Yuha drill hole, south of Dixieland, Imperial County.

Pliocene: At the type locality (coll. by F. I. Shepherd); Coyote Mt., Imperial County (Hanna); abundant in beds east of foot of Coyote Mountain (coll. by E. H. Quayle and U. S. G.); Santa Antonita Point, Gulf of California, Mexico (Hanna and Hertlein).

W. P. Woodring has recently expressed the opinion that the Coyote Mountain deposits are of lower Miocene age. It is difficult to estimate the age of these beds because so little is known of other Lower California or more southern, Pacific, fossil faunas, and even the Recent fauna is imperfectly described. The present writers would therefore await more investigation of other localities before reaching a conclusion. As most of the Coyote Mountain fossils have already been listed as Pliocene, it is thought best to give this occurrence as Pliocene also. The variety *discus* differs surprisingly little from the Recent form. Another variety, *compressa* Wiedey[1], from the Temblor, middle

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[1] Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 109, pl. 9, figs. 1, 2, 1928.

Miocene, of Orange County, California, is also very similar. However, it does not have so sharp a basal margin and appears flatter. The type of *compressa* is rather small (greatest diameter 16 mm., height 7 mm.) and may be an immature individual. Its apparent flatness may be due partly to its immaturity.

In the Recent fauna of Lower California, Mexico, there is a very small, flattened species of *Architectonica* with two of the spiral cords at the peripheral margin of the base. There is also a minute species in the Pliocene of the San Diego well (U. S. National Museum collection).

Family TRUNCATELLIDAE

Genus **TRUNCATELLA** Risso, 1826

Shell small, subcylindrical, loosely coiled, apex obtuse or truncated when adult; aperture oval, entire, peristome continuous; operculum horny.

The young shells of this genus have slender elevated spires which break or wear off before they become fully mature. The California species have definite axial riblets.

Truncatella californica Pfeiffer

Truncatella californica Pfeiffer, Proc. Zool. Soc. London for 1857, p. 111; Binney, Terrest. Air-Breathing Moll. U. S., Vol. 4, p. 28, pl. 79, figs. 20, 22, 1859; Baker, Nautilus, Vol. 16, p. 41, 1902; Dall, U. S. Nat. Mus., Bull. 112, p. 160, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro (T. S. Oldroyd); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Barbara, California, to San Martin Island, Lower California, Mexico.

Truncatella stimpsoni Stearns

Truncatella stimpsoni Stearns, Proc. Calif. Acad. Sci., Vol. 4, p. 248, pl. 1, fig. 5, 1872; Dall, U. S. Nat. Mus., Bull. 112, p. 161, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Catalina Island, California, to Magdalena Bay, Lower California, Mexico (Dall).

This species is similar to *T. californica* but averages larger and lighter colored. It lives among rocks at low tide line.

Family SYNCERATIDAE

Genus **SYNCERA** Gray, 1821

Syncera Gray, Med. Repos. London, Vol. 15, p. 239, 1821; Gray, Proc. Zool. Soc. London for 1847, p. 150, 1847; Bartsch, Proc. U. S. Nat. Mus., Vol. 58, p. 163, 1920.
Assiminea W. E. Leach, in Fleming, Hist. Brit. Anim., p. 275, 1828.

Type (*fide* Gray, 1847), "*A. grayiana* Leach" = *S. hepatica* Gray.

Syncera translucens (Carpenter)

Jeffreysia translucens Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 657, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 219, 1866.
Hydrobia californica Tryon, Amer. Journ. Conch., Vol. 1, p. 221, pl. 22, fig. 11, 1865.
Syncera translucens Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 58, p. 164, pl. 12, fig. 7, 1920; Dall, U. S. Nat. Mus., Bull. 112, p. 161, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Vancouver Island, British Columbia, to Lower California, Mexico (Dall, 1921).

Family CAPULIDAE

Genus CAPULUS Montfort, 1810

The species of this genus have simple, somewhat irregular, cap-shaped shells. It is probably only a question of time before *C. californicus* Dall[1] or some related species is found fossil, at least in the Pleistocene; but at present the fossil record on the Pacific coast of North America is lacking. *C. californicus* is illustrated on plate 32, figure 33, for comparison with the shells of other simple cup or cap-shaped forms.

Family HIPPONICIDAE

Genus HIPPONIX Defrance, 1819

Amalthea Schumacher, Ess. Nouv. Syst. Habit. Vers Test., p. 181, 1817, not *Amalthea* Rafinesque, 1815.

Hipponix Defrance, Journ. Phys. Chim. Hist. Nat. Arts, Vol. 88, p. 217, 1819; Gray, Proc. Zool. Soc. London for 1847, p. 157, 1847; Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 46, p. 330, 1908; Woodring, Carnegie Inst., Publ. No. 385, p. 373, 1928.

Type (by subsequent designation, Gray, 1847), *Patella cornucopia* Lamarck, Paris Basin Eocene.

Amalthea Schumacher has often been used for *Hipponix* but appears to be a homonym of *Amalthea* Rafinesque[2] (Analy. Nat., p. 123, 1815, *fide* Woodring).

Hipponix antiquatus (Linnæus)

Patella antiquata Linnæus, Syst. Nat., Ed. 12, p. 1259, 1767.

Hipponix antiquatus Linnæus, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 134, pl. 40, figs. 93-99, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 244, 1888; Keep, West Coast Shells, p. 74, fig. 59, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 312, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 161, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Pliocene: Santa Antonita Point, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: "Pliocene" of Deadman Island [= Timms Point zone] and lower San Pedro series of Deadman Island (Arnold) and San Pedro (T. S. Oldroyd); palisades north of Santa Monica, Los Angeles County (collection of F. C. Clark).

Recent: Crescent City, California, to Panama and Galapagos Islands (Dall, 1921).

Hipponix antiquatus (Linnæus) variety **cranioides** Carpenter

Hipponix cranioides Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 428, 1864; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 135, pl. 40, fig. 6, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 244, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 312, 1903.

Hipponix antiquatus cranioides Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 161, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925.

Pleistocene: Santa Barbara (Cooper); lower San Pedro series at Nob Hill cut (Oldroyd), San Pedro, and Deadman Island; upper San Pedro series at Deadman Island and Los Cerritos, also at Spanish Bight, San Diego (Arnold).

Recent: Vancouver Island, British Columbia, to San Pedro, California (Dall, 1921).

Hipponix tumens Carpenter

Hipponix tumens Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 654, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 180, 1865; Tryon, Man. Conch., Ser. 1, Vol. 8, pl. 40, fig. 7, 1886; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 313, 1903; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 161, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

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[1] Described in the Nautilus, Vol. 13, p. 100, 1900, and illustrated in Bull. 112, U. S. Nat. Mus., p. 161, pl. 15, fig. 6, 1921; living from San Pedro to San Diego on Pectens.

[2] Sherborn, Index. Anim., gives *Amalthea* Rafinesque as a *nomen nudum*. The original reference has not been available to the present authors.

Pleistocene: Santa Monica (collection of F. C. Clark); lower San Pedro series of Nob Hill cut at San Pedro (Oldroyd) and Deadman Island (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); chiton bed at Point Firmin, Los Angeles County (Chace); upper Pleistocene at Pacific Beach, San Diego (Arnold); San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Crescent City to San Diego, California (Dall, 1921).

The name *Hipponix* has frequently been spelled with a "y." This being a pure misspelling, the errors have not been segregated in the foregoing synonymy.

In the Stanford University collections there are specimens labeled *Hipponix barbatus* Lamarck, collected by R. H. Palmer in the Pleistocene beds of Oaxaca, Mexico.

Family CREPIDULIDAE

Genus CREPIDULA Lamarck, 1799

Crepidula Lamarck, Mém. Soc. Hist. Nat. Paris, Ser. 1, Vol. 1, p. 78, 1799; Dall, Bull. Mus. Comp. Zool. Harvard College, Vol. 9, p. 79, 1881; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 123, 1886; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 354, 1892.

Type (by monotypy), *Patella fornicata* Linnæus, figured by Tryon, *op. cit.*, p. 124, pl. 36, figs. 1-8, 1886, Atlantic and Gulf coasts of North America, Recent.

Shell oval, limpet-like, with a large body whorl and large aperture, and a small, closely appressed spire of few whorls; interior with a shelly lamina, or shelf, covering the posterior part of the body cavity.

Geologic range: Cretaceous to Recent.

Section CREPIDULA, s. s.

Crepidula princeps Conrad

Crepidula princeps Conrad, U. S. Pacific R. R. Repts., Vol. 5, p. 326, pl. 6, figs. 52, 52*a*, 1856; Dall, in Spurr, U. S. Geol. Surv., Twentieth Ann. Rept., Pt. 7, p. 264, 1900; Arnold, Smithsonian Misc. Coll., Vol. 50, pp. 422, 424, 1907; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, pp. 26, 153, 1907; Arnold, Bull. 322, p. 58, pl. 24, figs. 1, 2, 1907; Proc. U. S. Nat. Mus., Vol. 34, pp. 350, 353, 354, 355, 1908; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 84, pl. 8, pl. 9, fig. 5, pl. 10, fig. 2, 1909; Arnold, Bull. 396, U. S. Geol. Surv., pp. 25, 26, 31, 35, 39, 152, pl. 23, fig. 2, 1910; Arnold and R. Anderson, Bull. 398, pp. 110, 126, 129, 132, 324, pl. 45, fig. 2, 1910; F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 100, 1911; W. F. Jones, Univ. Calif. Publ. Geol., Vol. 6, pp. 68, 71, 1911; J. P. Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 175, 1912; Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 43, 1914; English, Univ. Calif. Publ. Geol., Vol. 8, pp. 210, 213, 1914; Clark, p. 422, 1915; Nomland, Vol. 9, p. 206, 1916; Martin, pp. 229, 231, 243, 245, 256, 1916; Moody, Vol. 10, pp. 43, 46, 1916; Weaver, Proc. Calif. Acad. Sci., Ser. 4, Vol. 6, p. 38, 1916; Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 212, 221, 301, 1917; J. P. Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 9, pp. 136, 137, 144, 146, 151, 156, 160, 1919; Dickerson, Vol. 9, p. 550, 1922; Kew, U. S. Geol. Surv., Bull. 753, p. 78, 1924; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, pp. 77, 78, 79, 1929.

"Crepidula grandis Middendorff," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 534, 539, 590, 1864; Watts, Calif. State Mining Bureau, Bull. 3, pp. 40, 54, etc., 1894; Ashley, Proc. Calif. Acad. Sci., Ser. 2, Vol. 5, pp. 318, 320, etc., 1895; Watts, Calif. St. Mining Bureau, Bull. 11, p. 79, 1897; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 309, 310, 1903; Haehl and Arnold, Proc. Amer. Philos. Soc., Vol. 43, pp. 20, 24, 1904; not of Middendorff, 1849, nor of Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 216, 1857; Rept. for 1863, p. 584, 1864, nor of Dall, U. S. Nat. Mus., Bull. 112, p. 162, 1921, nor of I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 116, 1927.

"Crypta grandis Middendorff," Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 82, 1868; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 265, 1888, in part; Watts, Calif. State Mining Bureau, Bull. 3, p. 54, 1894, in part, not of Middendorff, 1849.

Shell large, thick, heavy, elongate, beak sharply twisted to the side and in most cases appressed to the body whorl but occasionally twisted somewhat outward, apex usually turned up away from the aperture; body whorl ventricose, with axis of greatest curvature well to the side (right) of the median line; sculpture of growth lines but no spiral or radial sculpture; aperture ovate or elliptical, lip simple or sometimes thickened at the apical edge, internal shelly septum extending over half of the aperture, concave, with a gentle curve at its juncture with the shell. Size: 93 mm. in length; 50 mm. in width; 41 mm. in height perpendicular to the plane of the aperture.

Miocene: Cape Yaktag, Alaska (Dall, in Spurr, 1900); lower Miocene of western Washington (Weaver); lower Miocene of La Panza quadrangle, San Luis Obispo County; of Searsville Road, 3 miles southwest of Stanford University campus, Santa Clara County (Arnold; Dall, 1909); upper Miocene of western Washington (Weaver); Empire formation of Oregon (Dall, 1909); Arnold and Hannibal, 1913); San Pablo formation of middle California (Merriam; Clark, 1915); etc.

Pliocene: Purisima formation, S. D. S. N. H. loc. 104, beach south of Purisima Creek (Grant and Gale); lower Merced of Seven Mile Beach, San Mateo County (Ashley; Martin); Merced of Año Neuvo Bay, San Mateo County, and Etchegoin of Sargent oil field, San Benito County (Martin); Etchegoin of Coalinga region (Nomland); Fernando of Santa Maria district, Santa Barbara County (Arnold); San Diego formation of Pacific Beach, S. D. S. N. H. loc. 100 (U. S. G.); middle Pliocene of Holser Canyon, Los Angeles County (H. R. G.); middle or upper Pliocene of the west branch of O'Hare Canyon, Ventura County (H. R. G.); upper Pliocene between Timber Canyon and Santa Paula Creek, and of Sulphur Canyon east of South Mountain, Ventura County (H. R. G.); etc.

Pleistocene: Lower Pleistocene of Adams Canyon; between Hampton and Aliso canyons; between Adams and O'Hare canyons, etc., Ventura County (U. S. G.); upper San Pedro formation of Deadman Island, Los Angeles County (Arnold, 1903, as *C. grandis*); etc.

This is a large, heavy species, which, though extinct, is represented by a direct descendent, *C. grandis* Middendorff, in the Recent boreal fauna. The Recent species is in most cases thinner shelled, less convex, and relatively broader than the fossil ancestor. Some of the Pleistocene specimens of *C. princeps* show a broadening and flattening which appears to be a step toward *C. grandis.*

Waterfall has recently described a *Crepidula* from the Pleistocene beds near Ventura as *Crepidula saugusensis.*[1] It appears to be an *onyx* or a young *princeps*, perhaps like the Pliocene specimens from localities 221 and 222 referred below to *onyx*. All the species of this genus are variable, and it is likely that many fossil records are based upon misidentifications.

It may be possible to distinguish the young of *C. princeps* from *C. onyx* by the character of the deck or shelly diaphragm. *C. princeps* generally has one broad curved indentation of the deck margin while *C. onyx* has two of unequal size.

Crepidula onyx Sowerby

Plate 32, Figure 34

Crepidula onyx Sowerby, Gen. Shells, No. 23, fig. 2, 1824; Carpenter, Proc. Zool. Soc. London for 1856, p. 225; Brit. Assn. Adv. Sci., Rept. for 1856, p. 323, 1857; Reeve, Conch. Icon., Vol. 11, *Crepidula*, pl. 2, figs. 9*a*, 9*b*, 1859; Tryon, Man. Conch., Ser. 1, Vol. 8, pl. 37, fig. 37, pl. 38, figs. 43-50, pl. 39, fig. 59, 1886; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 310, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 174, pl. 23, figs. 2, 5, 1909; J. P. Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 175, 1912; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 593, 1913; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Clark, Vol. 8, pp. 405, 422, 1915; Nomland, Vol. 9, p. 82, 1916; Martin, Vol. 9, pp. 229, 256, 1916; Dall, U. S. Nat. Mus., Bull. 112, p. 162, 1921; Dickerson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, p. 564, 1922; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 92 and table opposite, 1922; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 448, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 117, 1927.

Crepidula rugosa Nuttall, MS., Carpenter, Proc. Zool. Soc. London for 1856, p. 224; Brit. Assn. Adv. Sci., Rept. for 1863, p. 654, 1864; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 128, pl. 37, fig. 37, 1886.

Crepidula onyx Sby., var. *rugosa* Nuttall, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 203, 1893.

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[1] Univ. Calif. Publ. Geol., Vol. 18, p. 87, pl. 6, fig. 7, 1929.

Miocene: Empire formation of Coos Bay, Oregon (Howe); upper and lower San Pablo and Santa Margarita formations (Clark, 1915).

Pliocene: Coyote Mountain, Imperial County (Hanna); Jacalitos and Etchegoin formations (Clark, 1915); middle Pliocene of localities 221 and 222, Ventura County, common (H. R. G.); two specimens irregularly striated as in *rugosa* from locality 217*b*, Holser Canyon, Los Angeles County (H. R. G.).

Pleistocene: Lower San Pedro series at San Pedro and Deadman Island (Arnold) and Nob Hill cut (T. S. Oldroyd); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro series at Deadman Island, San Pedro, and Los Cerritos, Los Angeles County, and Pacific Beach and Spanish Bight, San Diego (Arnold); Santa Monica, Los Angeles County (Oldroyd Collection at Stanford University).

Recent: Monterey, California, to Panama (Dall, 1921).

This species is much smaller than *C. princeps.* It is much like *C. fornicata* of the Atlantic coast, and it is entirely possible that the Ventura County Pliocene specimens noted above, even that *onyx* as a whole, should be identified as *fornicata* or a variety of *fornicata.*

Crepidula adunca Sowerby

Crepidula adunca Sowerby, Cat. Tankerville, Appen., p. 7, 1825; Reeve, Conch. Icon., Vol. II, *Crepidula*, pl. 2, fig. 12, 1859; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 82, 1868-9; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 129, pl. 38, figs. 51-55, pl. 37, figs. 39, 40, pl. 39, fig. 60, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 236, 1888; Dall, Trans. Wagner Inst. Sci., Vol. 3, pp. 355, 358, 1892; Pilsbry and Vanatta, Proc. Wash. Acad. Sci., Vol. 4, p. 552, 1902; Arnold, Mem. Calif. Acad. Sci., Vol. 3, pp. 55, 308, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 422, 1915; Nomland, Vol. 9, p. 203, 1916; Moody, Vol. 10, p. 43, 1916; Nomland, Vol. 10, pp. 212, 221, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 162, 1921; I. S. Oldroyd, Univ. Wash. Publ. Puget Sound Biol. Sta., Vol. 4, p. 158, pl. 11, fig. 6, 1924; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Crepidula rostriformis Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 160, 1846; U. S. Expl. Exped., Vol. 12, p. 375, 1852, Atlas Moll., fig. 482, 1856.

Miocene: Empire formation of Coos Bay, Oregon (Howe); upper San Pablo formation of middle California (Clark).

Pliocene: Etchegoin formation of Coalinga region (Nomland); Fourth and Broadway, Los Angeles (Moody); Bath-house Beach, Santa Barbara (Berry).

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro (Arnold) and of Nob Hill cut at San Pedro (T. S. Oldroyd); Barlow's Ranch, near Ventura (Arnold); "Saugus" formation near Ventura (Waterfall); upper San Pedro series in San Pedro region (Arnold) and at Santa Monica (coll. of F. C. Clark); Spanish Bight, San Diego (Arnold); etc.

Recent: Vancouver Island, British Columbia, to Cape San Lucas, Lower California, Mexico (Dall, 1921).

This is an oval, nearly round shell with the beak hardly twisted and usually elevated above the plane of the aperture. It is likely that the Miocene records should be assigned to *C. prærupta* Conrad or some other species.

Crepidula aculeata (Gmelin)

Patella aculeata Gmelin, Syst. Nat., Ed. 13, p. 3320, 1790.

Crepidula aculeata Gmelin, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 129, pl. 39, figs. 61-65, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 236, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 308, 1903; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 162, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925.

Pliocene: San Fernando, Los Angeles County (Cooper); Florida (Dall, *fide* Arnold).

Pleistocene: "Rare in lower San Pedro series of San Pedro and Deadman Island" (Arnold); Nob Hill cut, San Pedro (T. S. Oldroyd); Point Firmin chiton bed (Chace); all in Los Angeles County.

Recent: Santa Barbara, California, to Valparaiso, Chile (Dall, 1921); ? also Atlantic.

Crepidula aculeata can be recognized by its crenulated radial sculpture. *Calyptræa echinus* Broderip and *Calyptræa hystrix* Broderip may be synonyms.

Crepidula excavata (Broderip)

Calyptræa excavata Broderip, Proc. Zool. Soc. London for 1834, p. 46, 1834; Trans. Zool. Soc. London, Vol. 1, p. 205, pl. 29, fig. 7, 1835.

Crepidula excavata Broderip, Dall, Nautilus, Vol. 32, p. 24, 1918; U. S. Nat. Mus., Bull. 112, p. 162, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro (T. S. Oldroyd); Magdalena Bay (Dall, 1918), and upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan); Santa Monica palisades, Los Angeles County (Oldroyd Collection at Stanford University).

Recent: Monterey, California, to Payta, Peru (Dall, 1921).

Section CREPIPATELLA Lesson, 1830

Crepidula lingulata Gould

Crepidula lingulata Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 160, 1846; U. S. Expl. Exped., Vol. 12, p. 376, 1852, Atlas Moll., figs. 481, 481*a-c*, 1856; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

"*Crepidula dorsota* Broderip," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 654, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 236, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 309, 1903, not *Crepidula dorsata* Broderip, 1834.

Crepidula (*Crepipatella*) *lingulata* Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 162, 1921.

Pliocene: San Fernando, Los Angeles County (Cooper); ? Santa Barbara (Cooper, as Pleistocene).

Pleistocene: Rare in lower San Pedro series of Deadman Island, Los Angeles County (Arnold); lower Quaternary at Magdalena Bay, Lower California (Jordan, 1924, identification by Dall); upper San Pedro series of Crawfish George's and Los Cerritos, Los Angeles County (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Bering Sea to Panama (Dall).

This flattish, crudely radially sculptured species can be recognized by its distinctive deck which protrudes into the body cavity separated from the shell for some distance on one side. The margin of the deck has one small V-shaped indentation due to a low radial fold which probably compensates structurally for the lack of complete lateral attachment to the shell.

Section IANACUS Mörch, 1852

Crepidula nummaria Gould

Crepidula navicelloides Nuttall, in Jay's Cat. Shells, Ed. 3, p. 41, 1839, *nomen nudum;* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 654, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 82, 1868-9; Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 297, 1874; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 237, 1888; Keep, West Coast Shells, p. 76, fig. 61, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 310, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908.

Crepidula nummaria Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 160, 1846; U. S. Expl. Exped., Vol. 12, p. 377, 1852, Atlas Moll., figs. 480, 480*a-b*, 1856; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Crepidula (*Ianacus*) *nummaria* Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 163, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 120, pl. 91, figs. 14, 14*a-b*, 1927.

Type locality: Classet, Puget Sound, Recent.

Pliocene: San Diego well, Balboa Park, San Diego (Dall, as *C. navicelloides* Nuttall); Bath-house Beach, Santa Barbara (Arnold; Berry; as *navicelloides*).

Pleistocene: Lower San Pedro series of Deadman Island, "rare" (Arnold); lower San Pedro series of Nob Hill cut at Second and Pacific Streets, San Pedro, "plentiful" (Oldroyd, 1925); upper San Pedro series of Crawfish George's, Los Cerritos, San Pedro, and Deadman Island, Los Angeles County (Arnold).

Recent: Plover Bay, Bering Strait, to Mazatlan, Mexico (Dall, 1921).

This is typically a round, flat, rather thin-shelled species, but it varies with its situs, sometimes being quite elongate or irregular. *C. nivea* C. B. Adams is probably a synonym or a variety. This species, like the other Pacific coast species, needs more careful study before specific limits can be determined.

Family CALYPTRAEIDAE

Genus CRUCIBULUM Schumacher, 1817

Crucibulum Schumacher, Ess. Nouv. Syst. Habit. Vers Test., pp. 56, 182, 1817.

Section Crucibulum, s. s.

Adult with entire margin of internal cup free from shell wall.

Crucibulum spinosum (Sowerby)

Calyptræa spinosa Sowerby, Gen. Shells, pl. 23, figs. 4, 7, 1824.

Crucibulum spinosum Sowerby, Conrad, U. S. Pac. R. R. Repts., Vol. 5, p. 327, pl. 5, fig. 46, 1856; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 323, pl. 9, figs. 3*a*-3*p* (explanation of plate on p. 3), 1857; Reeve, Conch. Icon., Vol. 11, *Crucibulum*, pl. 4, figs. 10*a*-*k*, 1859; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 654, 1864; Tryon, Man. Conch., Ser. 1, Vol. 8, pl. 32, fig. 38, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 237, 1888; Keep, West Coast Shells, p. 77, fig. 62, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 306, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 233, 1909; Nautilus, Vol. 32, p. 24, 1918; U. S. Nat. Mus., Bull. 112, p. 163, 1921; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 448, 1926; Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; Hanna and Hertlein, Vol. 16, p. 142, 1927; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 251, 1929.

Pliocene: Coyote Mountain, Imperial County (Hanna); San Diego well (Dall, *fide* Arnold); Carmen Island, Gulf of California (Hanna and Hertlein); Santa Barbara (Cooper).

Pleistocene: Lower San Pedro series of Deadman Island, "common" (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (Dall, 1918; Jordan, 1924); upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, Long Beach, and Crawfish George's (Arnold), and of the Santa Monica palisades (collection of F. C. Clark), Los Angeles County; foot of Twenty-sixth Street, San Diego (Stephens); upper Pleistocene at San Quintin Bay (Jordan, 1926) and of coast of Oaxaca, Mexico (Palmer).

Recent: Trinidad, California, to Tome, Chile, and the Galapagos Islands (Dall, 1921).

Crucibulum imbricatum (Sowerby)

Calyptræa imbricata Sowerby, Gen. Shells, No. 23, fig. 5, 1824; Broderip, Proc. Zool. Soc. London, Pt. 2, p. 36, July, 1834.

Crucibulum imbricatum "Broderip," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 3, pl. 9, figs. 1*a*-*g*, 1857; Reeve, Conch. Icon., Vol. 11, *Crucibulum*, pl. 3, figs. 8*c*, 8*d*, 9*c*, 9*d*, 1858; Mabille, Bull. Soc. Philom. Paris, Ser. 8, Vol. 7, p. 58, 1895.

Crucibulum imbricatum Sowerby, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 233, 1909; Nautilus, Vol. 32, p. 24, 1918; Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 149, 152, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 142, 1927.

Pliocene: Coronados Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Lower Quaternary at Magdalena Bay (Dall; Jordan), and upper Pleistocene at Scammons Lagoon (Jordan), Lower California, Mexico.

Recent: Gulf of California to Callao, Peru, and the Galapagos Islands (Dall, 1909).

In the collections at Stanford University there are specimens labeled *C. scutellatum* Gray, *C. tenue* Broderip, and *C. umbrellum* Deshayes, all collected by R. H. Palmer from the Pleistocene on the coast of Oaxaca, Mexico.

Genus CALYPTRAEA Lamarck, 1799

Calyptræa Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 78, 1799.

Type (by monotypy), *Patella chinensis* Linnæus.

Shell conical, with a central or subcentral apex that may be spiral; aperture basal, with an internal spiral diaphragm, which has a twisted columellar border.

Cheilea Modeer, 1793, is a genus of conical, cup-shaped shells with an imperfect funnel-like process within. It is generically distinct from *Calyptræa*.

Calyptræa mamillaris Broderip

Plate 32, Figures 24*a*, 24*b*

Calyptræa mamillaris Broderip, Proc. Zool. Soc. London for 1834, p. 38, July, 1834; Trans. Zool. Soc. London, Vol. 1, p. 201, pl. 28, fig. 5, 1835, placed questionably in subgenus *Siphopatella;* Tryon, Man. Conch., Ser. 1, Vol. 8, pl. 34, figs. 64-67, 1886; Strong, Nautilus, Vol. 39, p. 9, 1925; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 341, pl. 32, fig. 10, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Calyptræa (*Trochatella*) *mammillaris* Broderip, d'Orbigny, Voy. Amer. Mérid., Moll., p. 462, 1841.

Calyptræa fastigiata Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 161, 1846; Rept. U. S. Expl. Exped., Vol. 12, p. 379, 1852, Atlas, Moll., pl. 32, figs. 484, 484*a-b*, 1856; Dall, U. S. Nat. Mus., Bull. 112, p. 163, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 18, 1925; Strong, Nautilus, Vol. 39, p. 9, 1925.

Trochita inornata Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 51, 81, pl. 14, fig. 8*a*, 1868-9; Merriam, Univ. Calif. Publ. Geol., Vol. 2, p. 106, 1896; Reagan, Trans. Kansas Acad. Sci., Vol. 22, pp. 171, 195, pl. 3, fig. 31, 1909; Clark, Vol. 8, p. 421, 1915; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 243, 1916; Howe, Vol. 14, table opp. p. 93, 1922.

Galerus inornatus Cooper, Bull. Calif. State Mining Bureau, No. 11, pp. 79, 82, 1896.

Galerus mammillaris Broderip, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 307, 1903.

Calyptræa (*Trochita*) *inornata* Gabb, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 82, pl. 5, figs. 6, 11, pl. 6, fig. 4, 1909.

Calyptræa inornata Gabb, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913.

Miocene: Empire formation of Coos Bay, Oregon (Dall; Arnold and Hannibal; Howe); San Pablo formation, upper Miocene of middle California (Clark).

Pliocene: Merced and Purisima formations of San Francisco region (Martin; etc.); Etchegoin formation of San Joaquin basin (Clark); San Diego well, San Diego (Dall, *fide* Arnold, 1903); "Pico" formation near Ventura (Waterfall); near Half Moon Bay, San Mateo County (Gabb, as Miocene); etc.

Pleistocene: Upper and lower Pleistocene of San Pedro region (Arnold; T. S. Oldroyd).

Recent: Alaska to South America.

C. fastigiata Gould is a name given to the northern smaller individuals. The type locality of *fastigiata* is Puget Sound.

Recent conchologists consider *Calyptræa fastigiata* and *C. mamillaris* distinct species, basing their reasons for so doing on the difference in the ranges of the northern and the southern shells which do not overlap but are separated by over a thousand miles of coast line. The southern form (*C. mamillaris*) may be slightly thicker shelled and perhaps average a very little larger, but such differences are not greater than can be found between shells chosen from the extremities of the ranges of many other species. In fact the differences between these two species are very much smaller than the differences between many other species, and objectively considered they appear conspecific. *C. fastigiata* ranges only as far south as Puget Sound, so far as known, while *C. mamillaris* does not live as far north as San Diego, part of the intermediate region being occupied by *C. contorta*, which is possibly a distinct species. Such an anomalous range is difficult to explain on the basis of temperature control, but it is possible that some other influence, as yet unknown, accounts for the hiatus in distribution. In this case it may be due to control by the presence of some enemy or absence of food; or the northern individuals became separated from the southern stock by diastrophic events, and having become permanently adjusted to northern conditions they are now intolerant of other conditions. Such possibilities are entirely speculative, however; and it seems more likely, either that *contorta* is the same species and there is no real hiatus, or that *mamillaris* and *fastigiata* are also distinct.

Calyptræa filosa (Gabb)

Trochita filosa Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 15, pl. 2, figs. 25, 25*a*, 1866; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 545, pl. 50, figs. 2, 2*a*, 1907; U. S. Geol. Surv., Bull. 309, pl. 40, figs. 2, 2*a*, 1907; English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Clark, Vol. 8, p. 421, 1915; Martin, Vol. 9, p. 255, 1916; Nomland, Vol. 10, p. 221, 1917.

Miocene: San Pablo and Santa Margarita formations of middle California (Clark).
Pliocene: Common in the Jacalitos and Etchegoin formations of the Coalinga district (Nomland); Etchegoin and Merced of Sargent oil field, San Benito County, and Purisima and lower Merced of San Franciscan region (Martin); lower Pliocene of Elsmere Canyon (Arnold; English).

This species ranges from the upper Miocene into the middle Pliocene, so far as known. The sutures are less distinct and the radial sculpture much finer than in *Calyptræa trochiformis* (Gmelin).

Subgenus **TROCHITA** Schumacher, 1817

Calyptræa (Trochita) trochiformis (Gmelin)

Plate 31, Figure 11

Patella trochiformis Gmelin, Syst. Nat., Ed. 13, Vol. 8, p. 3693, 1790.
Trochus radians Lamarck, Hist. Anim. s. Vert., Vol. 7, p. 11, 1822.
Calyptræa radians Lamarck, Hist. Anim. s. Vert., Deshayes and Milne Edwards Ed., Vol. 7, p. 626, 1836.
? *Trochita costellata* Conrad, U. S. Pacific R. R. Repts., Vol. 7, p. 195, pl. 7, fig. 3, 1857; Arnold, U. S. Geol. Surv., Bull. 309, p. 236, pl. 32, fig. 3, 1907; not *Calyptræa costellata* Philippi, Arch. f. Naturg., Vol. 11, pt. 1, p. 62, 1845.
Calyptræa (*Infundibulum*) *radians* Lamarck, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 121, pl. 35, figs. 84, 85, 1886.
? *Calyptræa costellata* Conrad, Clark, Univ. Calif. Publ. Geol., Vol. 7, p. 54, 1912.
? *Calyptræa martini* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 486, pl. 70, fig. 8, 1915.
Calyptræa radians "Arnold," English, Univ. Calif. Publ. Geol., Vol. 8, p. 210, 1914; Carson, Bull. So. Calif. Acad. Sci., Vol. 25, p. 49, 1926.

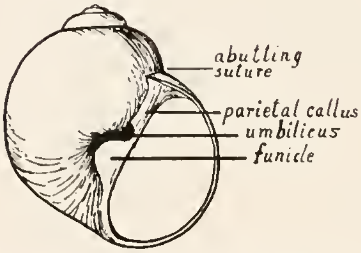
Miocene: Three miles south of Calabasas, Los Angeles County, in the Topanga formation (a local name for the Temblor formation, lower middle Miocene); "common in the Miocene" (Arnold, as *Trochita costellata* Conrad); upper San Pablo east of Walnut Creek, Contra Costa County, and uppermost fossiliferous beds of the Santa Margarita formation, north of Coalinga (Clark, 1915, as *C. martini*); etc.
Pliocene: Fugler Point asphalt mine, one mile north-northwest of Gary, at head of Santa Maria Valley (Arnold); "Fernando" of Holser Canyon, Los Angeles County (English); Puente Hills, Los Angeles County (Carson).
Recent: Panama to Peru.

In the second edition of Lamarck's "Histoire Naturelle des Animaux sans Vertèbres," *Calyptræa radians* is stated to be conspecific with Gmelin's earlier name *Patella trochiformis;* hence we have used the prior name. In the California Miocene a fossil *Calyptræa* occurs which is identical with the Recent species of South America. It is a large species with numerous prominent axial ribs. This Miocene fossil has been called *Trochita* or *Calyptræa costellata* Conrad (not *Calyptræa costellata* Philippi, 1845). Conrad's type was a sandstone cast from Gaviota Pass, Santa Barbara County, probably lower Miocene but possibly upper Eocene. His figure, which is characteristically poor, shows no sign of the radiating ribs which are so conspicuous on the fossil to which his name has been applied and which are mentioned in his description. A comparison of

Conrad's type with specimens collected from Gaviota Pass would probably settle the uncertainty over Conrad's species.

Clark (1912) reported *Calyptræa costellata* from the lower part of the San Pablo series in the Kirker's Pass region, Contra Costa County, but in a later paper he stated his former identification was wrong and that the shell was a new species which he described as *Calyptræa diabloensis*.[1] In the same paper he described *Calyptræa martini*, which, from his figure, appears to be identical with the Recent South American shell. A careful study of a series of Miocene specimens of this clan may show that there is but one species with two or possibly three varieties in the California fossil faunas.

This species is the type of the subgenus *Trochita* Schumacher.



TEXT FIGURE 9. A Naticoid shell illustrating the application of descriptive terms.—From Marwick.

Family NATICIDAE

Shell globular or oval, spire usually short, aperture semilunar, without canal or anterior notch, the outer lip sharp, the columellar lip callous, more or less reflected over the umbilicus. (Tryon.)

Some of the terms applied to shells of this family are illustrated in the text figure taken from Marwick.

Genus NATICA Scopoli, 1777

Natica Adanson, Hist. Nat. Senegal, p. 172, 1757, pre-Linnæan.

Natica Scopoli, Introductio ad Historiam Naturalem, p. 392, 1777; Harris, Cat. Tert. Moll. Brit. Mus., Pt. 1, p. 255, 1897; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 332, 1908; U. S. Geol. Surv., Prof. Paper 59, p. 85, 1909; Marwick, Trans. New Zealand Inst., Vol. 55, p. 548, 1924; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 323, 1927; Woodring, Carnegie Inst., Publ. No. 385, p. 377, 1928.

Type (by subsequent designation, Harris, 1897), *Nerita vitellus* Linnæus, figured by Tryon, Man. Conch., Ser. 1, Vol. 8, p. 29, pl. 8, fig. 60, 1886, Philippines, Singapore, Recent.

Subgenus **NATICA**, s. s.

Shell globose, solid, smooth, suture well marked and generally abutting, aperture semilunar, outer lip straight, inclined 20-30° from vertical, inner margin with moderate callus on parietal wall, generally not invading umbilicus, which is open and contains a funicle spiralling up apertural wall. (Marwick, 1924.)

The typical subgenus is represented on the Pacific coast by but few species. *Tectonatica* has a smooth operculum in addition to a closed umbilicus. Woodring (1928) questions the value of opercular characters. He points out that Dall used *Natica, s. s.*, for the *canrena* group, for which *Naticarius* Duméril is a more appropriate name.[2]

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[1] Univ. Calif. Pub. Geol., Vol. 8, p. 485, pl. 70, fig. 9, 1915.

[2] Zool. Analytique, p. 164, 1805. The assumption that *Naticarius* is a substitute name for *Natica* Lamarck, 1799, not Scopoli, 1777, is probably unwarranted; but in this case it makes no difference, for Froriep, who was the first to assign species to the genus, cited in his translation of Duméril, p. 165, 1806, the sole species *Nerita canrena* Linnæus, which becomes the type by monotypy of *Naticarius* Duméril as well as of *Natica* Lamarck. See Iredale, Proc. Malac. Soc. London, Vol. 12, p. 83, 1916.

Natica (Natica) unifasciata Lamarck

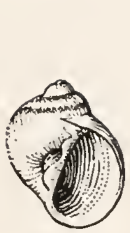
Text Figure 10

Natica unifasciata Lamarck, Hist. Nat. Anim. s. Vert., Vol. 6, pt. 2, p. 201, 1822; Deshayes and Milne Edwards Ed., Vol. 8, p. 640, 1838; Reeve, Conch. Icon., Vol. 9, *Natica*, pl. 12, figs. 49*a*, 49*b*, 1855; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 235, 1909; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 451, 1926.

Natica (*Natica*) *marochiensis* Gmelin, var. *unifasciata* Lamarck, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 23, pl. 5, fig. 93, 1886.

Pliocene: Coyote Mountain, western Imperial County (Hanna).
Pleistocene: Magdalena Bay, Lower California, Mexico (Hanna).
Recent: Panama north to Gulf of California. ? Peru.

This species is something like *N. canrena* but lacks the multiple spiral sulcations on the exterior of the operculum. It does not belong to the Section *Naticarius* Duméril, if this opercular character is of significance. The umbilical characters are the same.



TEXT FIGURE 10. *Natica unifasciata* Lamarck, a typical *Natica*, Recent specimen from the Gulf of California in the Oldroyd Collection at Stanford University; natural size.

Subgenus **TECTONATICA** Sacco, 1890

Tectonatica Sacco, Bollettino Musei Zoologia Anatomia Comparata R. Universita Torino, Vol. 5, (No. 86), p. 33, 1890; Cossmann, Ess. Paléo. Comp., Vol. 13, p. 119, pl. 2, figs. 13, 14, 1925; Woodring, Carnegie Inst., Publ. No. 385, p. 384, 1928.

Cryptonatica Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 362, 1892; U. S. Geol. Surv., Prof. Paper 59, p. 85, 1909; not of Kittl, 1894.

Type (by monotypy) *Natica tectula* Bonelli, Italian Pliocene.

Shell globose; umbilicus entirely filled with a callus deposit; operculum externally smooth.

Natica (Tectonatica) clausa Broderip and Sowerby

Text Figure 11

Natica clausa Broderip and Sowerby, Zool. Journ., Vol. 4, p. 360, 1829; Zool. Beechey's Voyage, p. 136, pl. 34, fig. 3, pl. 37, fig. 6, 1839; Wood, Mon. Palæontographical Soc., Vol. 1, p. 147, pl. 16, figs. 2*a*, 2*b*, 1848; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 77, 1868-9; Jeffreys, Ann. Mag. Nat. Hist., Ser. 4, Vol. 11, p. 206, 1872; Verrill, Amer. Journ. Sci., Ser. 3, Vol. 5, p. 472, 1873; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 30, pl. 9, fig. 65, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 253, 1888; Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896; Berry, Nautilus, Vol. 22, p. 38, 1908; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 590, 593, 594, 597, 598, 1913; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 257, 1916; Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93, 1922; Meek, Vol. 14, p. 418, 1923.

Natica (*Cryptonatica*) *clausa* Broderip and Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 313, pl. 10, fig. 13, 1903; Reagan, Trans. Kansas Acad. Sci., Vol. 22, p. 224, pl. 6, fig. 63, 1909; Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 44, 1916; Dall, U. S. Nat. Mus., Bull. 112, p. 163, pl. 14, fig. 11, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 122, pl. 97, fig. 2, 1927.

Natica clausa Deshayes, S. Tokunaga, Journ. Coll. Sci., Imperial Univ. Tokyo, Vol. 21, p. 17, pl. 1, fig. 31, 1906.

Natica (*Cryptonatica*) *consors* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 86, pl. 5, fig. 10, pl. 6, fig. 9, 1909.

? Natica (*Neverita*) *convexa* Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 86, pl. 7, figs. 1, 2, January 20, 1916.

Shell of medium size, globose, smooth; sutures abutting; spire slightly elevated; whorls about four, evenly convex or slightly shouldered. Height, about 27 mm.; width, 25 mm.; aperture, 20 x 12½ mm.; deflection, 15°.

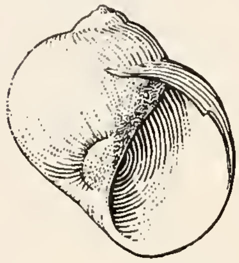
Miocene: Astoria, Oregon (Dall); Montesano formation of western Washington (Weaver); Empire formation of Coos Bay, Oregon (Dall; Arnold and Hannibal; Howe).

Pliocene: Lower Pliocene of Elsmere Canyon, Los Angeles County, one specimen (H. R. G.); upper Wildcat formation of Humboldt County, and Merced and Purisima formations of middle California (Martin); ? Etchegoin of middle California (Nomland, as *convexa*); British Crag (Wood); Coos conglomerate of Oregon (Arnold and Hannibal; Howe); "Fernando" of Los Angeles (Moody); S. D. S. N. H. locality 218, upper Pliocene east of South Mountain, Ventura County, five specimens (H. R. G.); Packard's Hill and Bath-house Beach, Santa Barbara (Arnold); etc.

Pleistocene: Near Tokyo, Japan (Tokunaga); "Pliocene" of Deadman Island and Timm's Point, Los Angeles County, rare (Arnold); Rockheath, Hampton, and Billockby, England (Wood); lower San Pedro of Deadman Island, very rare (Arnold); Peard Bay, Alaska (Meek).

Recent: Arctic and Bering seas, south in gradually deepening water, to Japan on the west and San Diego, California, on the east (Dall, 1921); Arctic off northern Europe and Greenland, south in the Atlantic to Massachusetts and off Portugal in deep water (Tryon).

This species is easily distinguished by its small, completely closed umbilicus, its globose shape, and abutting sutures. *Polinices reclusianus*, the most common species of this family on the California coast, varies from higher to shorter than *clausa*, but it is usually more conical in shape. *P. reclusianus* is further distinguished by its larger umbilicus, its much larger callus (which seldom completely fills the umbilicus and never is so closely united with the umbilical wall as in *N. clausa*), its tangential sutures and its usually larger size, to say nothing of its horny operculum. The figures by Dall (1921) and Oldroyd are easily accessible.



TEXT FIGURE 11. *Natica (Tectonatica) clausa* Broderip and Sowerby, Recent specimen from the Oldroyd Collection at Stanford University; natural size.

Mr. George Willett, who has done considerable collecting of Recent shells in the Alaskan region, points out that *Natica clausa* has probably been confounded with *N. russa* Gould, which has a similar, but larger shell, of a light brownish color, with a larger callus plug in the umbilicus. *N. clausa* is relatively rare in the Recent fauna of the northern part of the Pacific coast. Possibly some of the fossil records here grouped under *clausa* should be referred to *russa*.

The figures of *N. convexa* Nomland show a shell with the shape of *N. russa* except that the umbilical callus has a slightly different appearance. Perhaps partial decortication has changed the appearance of the callus. Perhaps the form is a variant of *Polinices reclusianus*. For the present, the writers, although they have not found an opportunity to examine authentic specimens,[1] believe that it is more probably a variant of *russa* or *clausa* than of *reclusianus*, and hence have tentatively placed it here.

Howe, who studied numerous specimens from the type locality of *N. consors* Dall, concluded that all these specimens represent *N. clausa*. A number of other synonyms or possible synonyms have been omitted from the above synonymy, as they would require more study than can be devoted to them at this time.

Natica (Tectonatica) russa Gould

Natica russa Gould, Proc. Boston Soc. Nat. Hist., Vol. 7, p. 43, June, 1859; Dall, Proc. Calif. Acad. Sci., Vol. 5, p. 251, 1874; Lowe, Nautilus, Vol. 18, p. 20, 1904.

Cryptonatica aleutica Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 352, 1919.

Natica aleutica Dall, Journ. Washington Acad. Sci., Vol. 9, p. 2, 1919.

Cryptonatica aleutica Dall, Proc. Biol. Soc. Wash., Vol. 32, p. 251, Dec. 31, 1919.

Natica (Cryptonatica) russa Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 163, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 123, 1927.

Natica (Cryptonatica) aleutica Dall, U. S. Nat. Mus. Bull. 112, p. 164, pl. 14, fig. 10, 1921; I. S. Oldroyd, Univ. Washington, Publ. Puget Sound Biol. Sta., Vol. 4, p. 161, pl. 22, fig. 12, 1924; Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 123, 1927.

"*Natica (Cryptonatica) clausa* Broderip and Sowerby," I. S. Oldroyd, Univ. Washington, Publ. Puget Sound Biol. Station, Vol. 4, pl. 3, fig. 3 (not the text), 1924; not of Broderip and Sowerby.

Type specimens: Of *russa?*; of *aleutica*, in U. S. National Museum.

Type locality: Of *russa*, Arctic Ocean; of *aleutica*, Unalaska, Alaska, Recent.

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[1] The type, which is now at the University of California, came from the Etchegoin Pliocene northeast of Coalinga, California.

Pliocene: St. George Island, Pribilof group (Dall, 1919); probably of many localities in California, listed as *clausa.*

Pleistocene: Probably many localities listed as *clausa.*

Recent: Bering Sea south to Catalina Island, California; also to Kamchatka and Japan.

This species attains a larger size than *Natica clausa.* It also has a distinctive brownish color and a larger callus plug than Broderip and Sowerby's species with which it has been undoubtedly confused. Mr. Willett, of the Los Angeles Museum, has a series of *N. russa* which well illustrates the uselessness of the name *aleutica.*

Genus **POLINICES** Montfort, 1810

Polinices Montfort, Conch. Syst., Vol. 2, p. 222, 1810; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 87, 1909; Marwick, Trans. New Zealand Inst., Vol. 55, pp. 549, 559, 1924; Stewart, Proc. Acad. Nat. Sci., Phila., Vol. 78, p. 325, 1927; Woodring, Carnegie Inst., Publ. No. 385, p. 385, 1928.

"*Polynices* Montfort," Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 367, 1892.

Type (by original designation), *Polinices albus* Montfort (= *Helix mamillaris* Linnæus, 1767, + *Natica brunnea* Link, figured by Tryon, Man. Conch., Ser. 1, Vol. 8, p. 43, pl. 18, fig. 74, 1886), West Indies, Recent.

Shell ovate to subcylindrical; sutures generally tangential; aperture with a thick parietal callus coalescing with the funicle and invading the umbilicus, which is sometimes completely filled, sometimes left widely open; operculum corneous. (Marwick.)

The shape, suture, size of the umbilicus, and nature of the umbilical calluses, as well as the corneous (instead of shelly) operculum, are useful in separating this genus from *Natica.* The parietal callus is much larger than in *Natica.*

In this genus, and to some extent in the other genera of the *Naticidæ,* there is a noticeable difference in the shells of the two sexes. The females are larger, with more inflated shoulders below the suture.

Subgenus **POLINICES,** s. s.

Shell oval or suboval, solid, smooth; aperture semilunar, inner lip oblique, callous, callus extending into and more or less completely filling the umbilicus (Tryon, Manual, description of *Mamma* Klein, a pre-Linnæan name).

This subgenus is characterized by its ovate or subcylindric shape with tangential sutures and smooth outline, but its limits are not always clearly defined.

Polinices (Polinices) uber (Valenciennes)

Text Figure 12

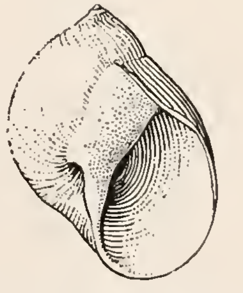
Natica uber Valenciennes, Humboldt's Voy., Vol. 2, p. 266, 1833; d'Orbigny, Voy. Amer. Mérid., p. 401, pl. 55, figs. 12-14, 1840, *fide* Dall, 1909; Reeve, Conch. Icon., Vol. 9, *Natica,* pl. 13, figs. 54*a*, 54*b*, 1855; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 48, pl. 17, fig. 61, 1886; Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 14, p. 451, 1926.

Polinices uber Valenciennes, Baker, Nautilus, Vol. 16, p. 41, 1902; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 235, 1909; Nautilus, Vol. 32, p. 24, 1918.

Pliocene: Coyote Mountain, Imperial County (Hanna).

Pleistocene: Magdalena Bay (Dall, 1918), west coast of Lower California, the Galapagos Islands, and Payta, Peru (Hanna).

Recent: San Martin Island, Lower California, Mexico (Baker), to Callao, Peru, and the Galapagos Islands (Dall, 1909).



Text figure 12. *Polinices uber* (Valenciennes), a typical *Polinices,* Recent specimen from Lower California in the Oldroyd Collection at Stanford University; natural size.

Polinices (Polinices) bifasciatus (Gray)

Natica bifasciata Gray, in Griffith's Cuvier, Anim. Kingd., Moll., p. 598, pl. 1, fig. 2, 1834; Reeve, Conch. Icon., Vol. 9, *Natica*, pl. 10, figs. 40*a*, 40*b*, 1855; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 44, pl. 18, fig. 75, 1886; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Pliocene: Coronados Island, Gulf of California, Mexico (Hanna and Hertlein).
Recent: Acapulco, Guaymas, and Cape San Lucas, Lower California, Mexico (Tryon).

This Mexican species is well figured by Reeve and Tryon.

It is probable that *Polinices ramonensis* (Clark) from the Oligocene and *Polinices arnoldi* (Clark) from the upper Miocene of middle California belong here. Possibly also *Polinices inezanus* (Conrad) from the Miocene of California and Oregon is a *Polinices, s. s.*, instead of a *Neverita.*

Subgenus **NEVERITA** Risso, 1826

Neverita Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 149, pl. 4, fig. 43, 1826; Marwick, Trans. New Zealand Inst., Vol. 55, p. 549, 1924.

Type (by monotypy), *Neverita josephina* Risso (= *N. olla* de Serres).

Shell ovate; sutures tangential, appressed; apertural callus thick, coalescing with a huge funicle, which fills the umbilicus; aperture greatly inclined (Marwick).

The greater inclination of the aperture, the more conical shape, and the larger umbilicus more solidly filled by the funicle distinguish this subgenus from *Polinices, s. s.*

Polinices (Neverita) reclusianus (Deshayes)

Text Figures 13*a*, 13*b*, 13*c*

Natica reclusiana Deshayes, Rev. Zool. Soc. Cuv., p. 361, 1839; Guerin's Mag. de Zool., Mollusca, pl. 37, 1841; Reeve, Conch. Icon., Vol. 9, *Natica*, pl. 1, fig. 3, 1855; Sowerby, Thes. Conch., Vol. 5, p. 76, pl. 1, fig. 6, 1883.

Neverita recluziana Deshayes, H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 208, 1853; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 77, 1868-9.

Neverita recluziana Petit, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Dall, Proc. Calif. Acad. Sci., Ser. 1, Vol. 5, p. 297, 1874; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 254, 1888; Keep, West Coast Shells, p. 46, fig. 26, 1888, 1892; Eldridge and Arnold, U. S. Geol. Surv., Bull. 309, pp. 25, 28, 107, 152, 153, pl. 38, fig. 6, 1907; Arnold and Anderson, Bull. 322, p. 59, pl. 21, figs. 14*a*, 14*b*, 15, 1907; Weaver, Univ. Calif. Publ. Geol., Vol. 5, p. 265, 1909; Arnold, Bull. 396, U. S. Geol. Surv., pp. 25, 26, 31, 35, 40, 44, pl. 20, fig. 2, Jan. 15, 1910; Arnold and Anderson, Bull. 398, pp. 110, 130, 133, pl. 42, fig. 2, 1910; Smith, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 176, 1912; English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914.

Natica (*Neverita*) *recluziana* Petit, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 34, pl. 12, fig. 1, 1886; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 211, 1892; Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 423, 1915; Vol. 9, p. 15, 1915; Nomland, p. 203, 1916; Martin, p. 257, 1916; Moody, Vol. 10, p. 44, 1916; Clark, Vol. 11, p. 167, 1918.

Polynices (*Neverita*) *recluziana* Deshayes, Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 369, 1892.

Polynices (*Neverita*) *recluziana* Petit, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 314, pl. 10, fig. 12 (not typical), 1903.

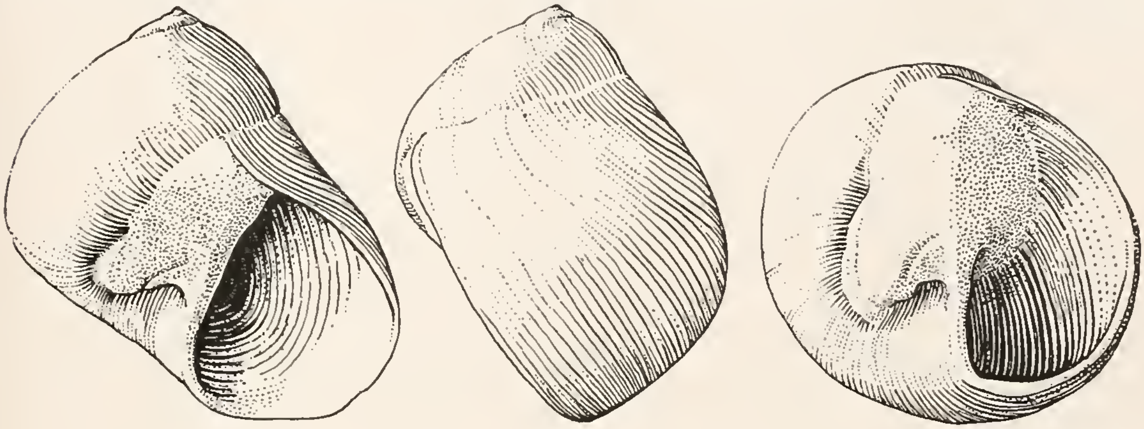
Polinices (*Neverita*) *recluzianus* Deshayes, Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 236, 1909; U. S. Nat. Mus., Bull. 112, p. 165, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 129, 1927; Hertlein and Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 630, 1927.

Natica recluziana Petit, Nomland, Univ. Calif. Publ. Geol., Vol. 10, pp. 221, 301, 1917; Wagner and Schilling, Vol. 14, pp. 244, 245, 248, 1923; Kew, U. S. Geol. Surv., Bull. 753, pp. 78, 88, 1924.

Polinices recluziana Deshayes, Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 150, 151, 1924.

Neverita reclusiana (Deshayes), Pilsbry, Nautilus, Vol. 42, p. 109, pl. 6, fig. 1, April, 1929.

Shell solid, conically globose, variable in shape; whorls four, in most cases only three visible when the outer shell layer is intact; callus very large, filling the posterior angle between the outer lip and the body whorl and extending around the columellar edge of the large umbilicus in a tongue-shaped mass, coalescing with another mass which extends over the rest of the umbilicus from about the middle of the inner lip, the two calluses separated by a more or less distinct shallow groove, the calluses completely covering over the umbilicus or leaving only a rounded hole at the outer anterior corner, the calluses bounded by an impressed edge next to the umbilical wall; size variable, like the shape. Average dimensions: Long. 30 mm., lat. 20 mm., or *vice versa.*



TEXT FIGURE 13. *Polinices* (*Neverita*) *reclusianus* (Deshayes), typical variety, Recent specimen in the Oldroyd Collection at Stanford University; natural size. Fig. 13*a*, apertural view; fig. 13*b*, side view; fig. 13*c*, basal view.

Oligocene: San Lorenzo formation or series of middle California (Clark); of the San Emigdio region, San Joaquin basin, Oligocene in part (Wagner and Schilling).

Miocene: Vaqueros formation (Arnold, 1910; Eldridge and Arnold); Temblor formation (Arnold and Anderson, 1907, 1910); Santa Margarita and San Pablo formations (Cooper; Arnold; Arnold and Anderson; Weaver; Smith; Nomland; Clark; etc.); Isidro formation, lower Miocene of Arroyo San Ignacio, Lower California, Mexico (Hertlein and Jordan).

Pliocene: Lower part (Cooper; Arnold; Smith; English; Nomland; etc.); middle (Dall, 1874; Arnold; Martin; Nomland; etc.); upper (Arnold, 1903; Moody; Martin; Kew; etc.);—reported from nearly every locality treated in the literature.

Pleistocene: Santa Barbara, San Pedro, San Diego (Cooper; Arnold, 1903);—common nearly everywhere.

Recent: Crescent City, California, south to the Tres Marias Islands, Mexico (Dall); ? Chile (Philippi).

This variable species has been reported in abundance from many localities along the Pacific coast, especially in California, from the Oligocene to the Recent. It has appeared in the literature under a great many specific and varietal names, most of them of very little or no significance; but in order to clarify the situation and bring out what value (if any) there may be in the distinctions, the varieties are here briefly reviewed. The species, as a whole, is of some value as an indication of temperature, not being found today north of California.

Variety **reclusianus**, s. s.

See references under the species, also:

Neverita recluziana alta Dall, Proc. U. S. Nat. Mus., Vol. 1, pp. 12, 27, 1878, no description; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917.

Polinices (*Neverita*) *recluziana*, var. *alta* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 88, 1909; not "*Neverita recluziana* var. *alta* Dall," Arnold, U. S. Geol. Surv., Bull. 396, pp. 32, 36, 40, pl. 20, figs. 5, 5*a*, 1910, nor Bull. 398, pp. 127, 130, pl. 42, same figures, which is another variation; Dall, U. S. Nat. Mus., Bull. 112, p. 165, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 130, 1927.

Pliocene: Etchegoin formation of Coalinga region (Arnold); upper Sargent and lower Merced of some middle California localities (Nomland); lower Pliocene of Elsmere Canyon and east of Fernando Pass; middle Pliocene (Pico) of Holser Canyon and southeast of Pico Canyon (H. R. G.).

Pleistocene: Lower San Pedro of Nob Hill cut (T. S. Oldroyd), and upper San Pedro series at several localities in San Pedro region (Arnold), Los Angeles County.

Recent: Monterey to San Diego and Catalina Island, California.

The typical variety[1] has a comparatively high, conical shape with a blunt apex. The portion of the body whorl just below the suture is concave. It is figured by Reeve, Sowerby, Tryon, etc., but not by Arnold, 1903, 1907, 1910. The typical variety seems to show distinctly the difference between the male and female shapes, the former, which is probably the variety *altus* Dall, is even taller and more slender than usual. The females are considerably more numerous than the males.

P. reclusianus, s. s., has probably been present from the Oligocene to the Recent, but is said to be less common in the older formations.

Polinices (Neverita) reclusianus (Deshayes) variety **andersoni** (Clark)

? *Polynices* (*Neverita*) *recluziana* Petit variety *alta* Dall, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 315, 1903.

"*Neverita callosa* Gabb," Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 43, 1914.

"*Neverita recluziana* Petit, typical form," Arnold, in various papers on California stratigraphy (see references under *recluzianus*, all except Arnold, 1903, in part, which is, in part, variety *callosus* (Gabb).

Natica (*Neverita*) *recluziana andersoni* Clark, Nomland, Vol. 10, p. 301, 1917, *nomen nudum* cited as "Clark (MS.)"; Clark, Univ. Calif. Publ. Geol., Vol. 11, p. 168, pl. 20, figs. 3, 10, 11, 12, 1918.

Oligocene to *Pliocene:* (Clark).

Pliocene: S. D. S. N. H. localities 202-207, 209, 210, Elsmere Canyon lower Pliocene; 215, 216, east of Fernando Pass; also various other localities in the lower and some in the middle Pliocene of the Santa Clara Valley region, Los Angeles and Ventura counties (H. R. G.); etc.

Pleistocene: S. D. S. N. H. locality 235, between Aliso and Hampton canyons (U. S. G.); locality 236, east of Harmon Canyon (U. S. G.); locality 243, Adams Canyon (H. R. G.), all Ventura County; etc.

Recent: This form is apparently even more common than the typical in the Recent fauna.

This variety, though still somewhat conical, has a lower spire than typical *reclusianus*, a sharper apex, the body whorl below the suture sloping off at a low angle and curving around broadly, with constantly increasing convexity, to the umbilicus. The shoulder that Clark speaks of is very inconspicuous on the specimens figured by him and is lacking on many other specimens which are otherwise the same. This variety does not have the concave portion of the body whorl just below the suture that is characteristic of the typical form, except in specimens that are leaning toward the typical form, and in them it is only slightly developed.

Polinices (Neverita) reclusianus (Deshayes) variety **pabloensis** (Clark)

? *Natica ocoyona* Conrad, U. S. Pacific R. R. Repts., Vol. 5, p. 328, pl. 7, figs. 57, 57*a* in text (51, 51*a* by misprint on plate), 1855.

Natica (*Neverita*) *pabloensis* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 488, pl. 68, figs. 12, 14, 1915.

Miocene: San Pablo and Briones formation (*Astrodapsis brewerianus* zone) of middle California (Clark).

Pliocene: S. D. S. N. H. locality 206, Elsmere Canyon, one specimen from the upper echinoid horizon (H. R. G.); middle Pliocene of Cañada de las Encinas, Ventura County, one specimen, and southeast of Pico Canyon, Los Angeles County, three specimens (H. R. G.); etc.

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[1] Pilsbry's paper on "*Neverita reclusiana* (Desh.) and its Allies" (Nautilus, Vol. 42, pp. 109-113, pl. 6, 1930) came to our attention after the manuscript on the *Naticidæ* had been completed and it was then too late to re-examine the collections. According to Pilsbry, the form called *altus* by Dall is a valid species and the variety *imperforata* a valid variety, both, however, subject to some uncertainty. We have examined a large series of specimens of *Polinices reclusianus* and its allies, and we believe *imperforatus* is of no taxonomic value whatsoever, the intergrades being common in large collections. The shells which Pilsbry assigns to *altus* (as a distinct species) are not the same as the ones referred to above as *altus*. They have a deep brown umbilical callus, which might be characteristic of a southern race. We do not recall having seen intergrades between the shells with a brown and those with a white umbilical callus, this difference in color appearing to be the most distinctive difference, if the form is at all valid. We seriously question its value. Pilsbry proposes the new section *Glossaulax* for the species with the groove in the umbilical callus, a prominent feature on most Recent specimens of this clan. The groove is often not clearly developed on *callosus* Gabb, though it is clearly shown in Gabb's figure. The section *Glossaulax* appears to have originated in the early Tertiary, probably in the middle or lower Eocene. In the Recent fauna it occurs on both sides of the Pacific Ocean. *Polinices reclusianus* (Deshayes) is the type of *Glossaulax* by original designation.

This variety has a lower spire than variety *andersoni*, and the last part of the body whorl forms a table which slopes down very gradually to the rounded shoulder. It may be the same as *ocoyanus* (Conrad), but insufficient material from Ocoya Creek has made identification with that form uncertain.

Polinices (**Neverita**) **reclusianus** (Deshayes) variety **callosus** (Gabb)

Text figure 14

Neverita callosa Gabb, Geol. Surv., Calif., Palæo., Vol. 2, p. 10, 1866, pl. 2, figs. 17, 17*a*, 17*b*, 1868-9; Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 542, pl. 44, figs. 4, 4*a*, 1907; U. S. Geol. Surv., Bull. 398, pp. 85, 86, 1910; not of Anderson and Martin, Proc. Calif. Acad. Sci., Ser. 4, Vol. 4, p. 43, 1914, *fide* Clark.

Polynices (*Neverita*) *recluziana* Petit, "typical shape," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 314, in part, pl. 10, fig. 12, 1903.

Polinices (*Neverita*) *recluziana* Deshayes var. *vancouverensis* Clark and Arnold, Univ. Calif. Publ. Geol., Vol. 14, p. 169, pl. 33, figs. 2*a*, 2*b*, 3, 1923.

Oligocene: Sooke formation, Washington (Clark and Arnold).

Miocene: Ranges throughout the Miocene (Arnold, 1907); Vaqueros formation (Arnold, 1910); Topanga Canyon, Los Angeles County (U. S. G.).

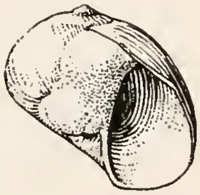
Pliocene: Lower Pliocene of S. D. S. N. H. localities 206 and 232, and Piru Creek below mouth of Holser Canyon, Los Angeles County; doubtfully in the Pliocene of O'Hare Canyon, Ventura County, and southeast of Pico Canyon, Los Angeles County (localities 223, 228, (H. R. G.)).

Pleistocene: Barlow Canyon, two specimens (U. S. G.); etc.

Recent: A few specimens in the Recent fauna conform to the characters of this variety.

This variety is like variety *andersoni* except that it is always smoothly rounded and the spire is sunken down even with, and is almost concealed by, the upper portion of the body whorl. The callus usually completely covers the umbilicus, though sometimes there is a small, rounded perforation. The type of *vancouverensis* (Clark and Arnold) is a *reclusianus*, variety *callosus*, leaning toward *andersoni*.

The variety *callosus* is quite common in the Temblor formation in Topanga Canyon. Specimens obtained from there show a variation in the height of spire as well as in the character of the umbilical callus. The groove on the umbilical callus of the Topanga Canyon specimens is sometimes nearly obsolete.



Text figure 14. *Polinices* (*Neverita*) *reclusianus* (Deshayes) variety *callosus* (Gabb), Recent specimen from the Oldroyd Collection at Stanford University; natural size. This specimen is leaning toward *andersoni*. It would appear much flatter if not held up in position.

Subgenus **EUSPIRA** Agassiz in Sowerby, 1838

Euspira Agassiz, in Sowerby, Min. Conch. Gt. Brit., German Ed., pp. 14, 320, 1838, *fide* Sherborn, Index Anim., Sect. 2, p. 2250, 1926; Agassiz, in Desor, Sowerby's Min. Conch., French Ed., pp. 14, 15, 16, 1839, *fide* Stewart, 1927; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 43, p. 333, 1908; U. S. Geol. Surv., Prof. Paper 59, p. 87, 1909; Marwick, Trans. New Zealand Inst., Vol. 55, p. 568, 1924; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 324 and footnote, 1927.

Lunatia Gray, Proc. Zool. Soc. London for 1847, p. 149, 1847.

"*Naticina* Guilding," Fischer, Man. de Conchyl., p. 766, 1885, not of Guilding, Trans. Linn. Soc. London, Vol. 17, p. 30, 1834.

Labellinacca Cossmann, Conch. Néog. Aquit., Vol. 3, p. 392, 1919; Ess. Paléo. Comp., Vol. 13, p. 137, 1925.

Not "*Euspira* Agassiz, 1837," Cossmann, Ess. Paléo. Comp., Vol. 13, pp. 50, 133, 138, 1925.

Type (by subsequent designation, Dall, 1908, 1909), *Natica glaucinoides* Sowerby, not Deshayes (= ? *Natica labellata* Lamarck). Sowerby's species is from the Eocene of England.

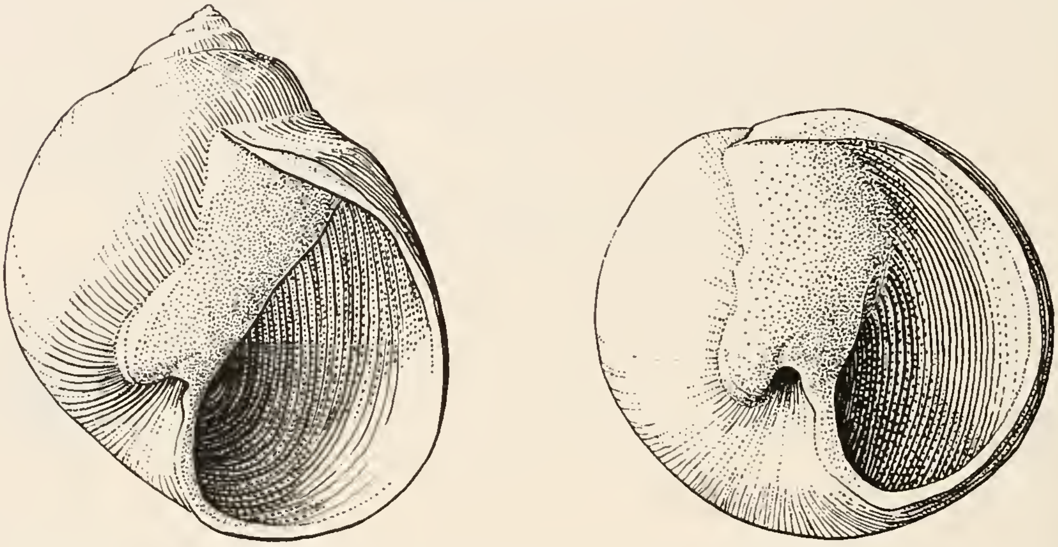
Shell globose; spire moderate; outer lip straight, slightly retracted to suture, inclined about 30° from vertical; inner margin with light callus on parietal wall; umbilicus open and without any funicle; operculum horny. (Marwick.)

Neither the French nor the German editions of Sowerby's Mineral Conchology have been available to the present authors. The original references given above have been taken from Sherborn and Stewart.

Contrary to Marwick's description, the species *lewisii* often has a large parietal callus. It is distinguished from *Neverita* by the underdeveloped funicle, which leaves the umbilicus open.

Polinices (Euspira) lewisii (Gould)

Text Figures 15*a*, 15*b*



15*a* 15*b*

TEXT FIGURE 15. *Polinices (Euspira) lewisii* (Gould), Recent specimen in the Oldroyd Collection at Stanford University; natural size. Fig. 15*a*, apertural view; fig. 15*b*, basal view.

Natica lewisii Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 239, 1847; Rept. U. S. Expl. Exped., Vol. 12, p. 211, 1852, Atlas Moll., pl. 15, fig. 253, 1856; Martin, Univ. Calif. Publ. Geol., Vol. 9, p. 257, 1916, as "*Natica*, near *lewisii* Gould."

Lunatia lewisii Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 661, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 77, 1868-9; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 35, pl. 13, fig. 11, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 247, 1888; Keep, West Coast Shells, p. 45, fig. 25, 1888, 1892; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 374, 1892; Arnold, U. S. Geol. Surv., Bull. 322, p. 58, pl. 21, fig. 3, 1907; Bull. 396, pp. 25, 26, 31, 35, 39, pl. 22, fig. 1, 1910; Arnold and Anderson, Bull. 398, pp. 109, 110, 127, 129, 133, pl. 44, same figures, 1910.

Polynices (Lunatia) lewisii Gould, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 315, pl. 10, fig. 14, 1903.

Polinices lewisi Gould, Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 325, pl. 38, fig. 1, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924.

Polinices (Euspira) lewisii Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 165, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, p. 127, 1927.

Shell of large size, only moderately heavy, sub-globose or conico-globose; whorls six, ventricose, with sutures abutting, shoulders high on the whorls, rounded, on the mature whorls with a concave flexure on the side of the whorl, nearly parallel to the suture; umbilicus moderately long, deep, with a slight encroachment down the right wall. Dimensions (from Gould): Axial diameter, 4½ to 5 inches; transverse diameter, 4 inches.

? Miocene: Kirker's Pass, Contra Costa County (Cooper, as Pliocene).

Pliocene: Listed questionably in the Jacalitos formation, lower Pliocene of Coalinga region (Arnold and Anderson); Wildcat, Etchegoin, Merced, Purisima, and Sargent formations of middle California (Martin, listed as a species near *lewisii*); Soquel, Santa Cruz County (Arnold); upper Etchegoin of Coalinga region (Arnold and Anderson); Fernando of Santa Maria district, Santa Barbara County (Arnold, 1907); west of Fernando Pass, one doubtful fragment (H. R. G.); San Fernando, Los Angeles County (Cooper).

Pleistocene: Lower part of the Pleistocene series in Adams Canyon, Ventura County, three specimens (H. R. G.); Santa Barbara; San Nicolas Island (Cooper); rare in the upper San Pedro series of San Pedro, Los Cerritos, Long Beach, Crawfish George's, and Deadman Island, Los Angeles County (Arnold, 1903).

Recent: Duncan Bay, British Columbia, to Santa Barbara Island, California (Dall, 1921); San Diego Bay (collection of Fred Baker).

This very large species is larger, less globular, and higher spired than *P. draconis* Dall. The slight, concave flexure on the side of the body whorl is also a distinguishing character. It is distinguished from *P. galianoi* Dall of the Oregon Miocene by its more ventricose whorls, more elevated spire, and the flexure on the body whorl. It can be most easily distinguished from *recluzianus* by its abutting sutures, more convex shoulders, and open umbilicus. The young can be distinguished from *N. clausa* only by the umbilical callus and the operculum.

Polinices (Euspira) galianoi Dall

Polinices (Euspira) galianoi Dall, U. S. Geol. Surv., Prof. Paper 59, p. 88, pl. 5, figs. 12, 13, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 591, 593, 1913; Howe, Univ. Calif. Publ. Geol., Vol. 14, p. 93 and table opposite, 1922.

Polynices galianoi Dall, Weaver, Univ. Wash. Publ. Geol., Vol. 1, p. 32, 1916.

Shell of moderate size, rather thick, moderately elevated; sutures abutting but with a slight tendency to be tangential; whorls about six, with comparatively straight sides and rounded shoulders; umbilicus moderate, open, its upper angle near the pillar lip filled with a small subtriangular callus; aperture ovate, narrowed above, a thin callus on the body. Dimensions about half those of *lewisii*, with the maximum transverse diameter longer than the axial.

Miocene: Montesano formation of western Washington (Weaver); Empire formation of Coos Bay, Oregon (Dall; Arnold and Hannibal).

Pliocene: Merced-Purisima of middle California (Arnold and Hannibal); S. D. S. N. H. locality 204, lower Pliocene of Elsmere Canyon, Los Angeles County, one poor specimen, questionably this species (H. R. G.).

Pleistocene: Barlow Canyon, Ventura County, one specimen.

This form is smaller and of different shape from *lewisii*, but it may be only a variety or variation of it.

Some fossils, especially small forms, of *lewisii* lack the faint flexure on the side of the body whorl. Both this form and *draconis* are difficult to distinguish from *lewisii*.

Polinices (? Euspira) orbicularis (Nomland)

Natica (Neverita) orbicularis Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 207, pl. 10, figs. 4*a*, 4*b*, 1916; Moody, Vol. 10, p. 44, pl. 2, fig. 6, 1916; Nomland, Vol. 10, p. 221, 1917.

Pliocene: Common in the *Chione elsmerensis* zone and *Turritella nova* zone, and rare in the *Pecten coalingensis* zone of Coalinga region; lower and upper Sargent, Purisima, and lower Merced of middle California (Nomland); Fernando of Los Angeles (Moody).

This form is most probably an immature or stunted variation of *lewisii*, and the name should be synonymized.

Genus SINUM Bolten, 1798

Sinum Bolten, Mus. Boltenianum, Pt. 2, p. 14, 1798; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 91, 1909; U. S. Nat. Mus., Bull. 90, p. 109, 1915; Woodring, Carnegie Inst., Publ. No. 385, p. 389, 1928.

Sigaretus Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 77, 1799, monotype, *Helix haliotoides* Linnæus.

Type (by subsequent designation, Dall, 1915), *Helix haliotoides* Linnæus.

Shell ear-shaped or Naticoid, spire small, low; body whorl rapidly enlarging, with a very large aperture; sculpture consisting of fine revolving grooves, sometimes crossed by curved growth lines; operculum small, horny, subspiral.

Sinum scopulosum (Conrad)

Sigaretus scopulosus Conrad, U. S. Expl. Exped., Geol., p. 727, pl. 19, figs. 6, 6*a* only, 1849; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 380, 1892; Dall, in Diller, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 474, 1896; F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 2, pp. 188, 203, pl. 16, figs. 72, 73, 1905; Arnold, U. S. Geol. Surv., Prof. Paper 47, pp. 17, 19, 1906; Reagan, Trans. Kansas Acad. Sci., Vol. 22, pp. 172, 194, pl. 3, fig. 30, 1909; Arnold, U. S. Geol. Surv., Bull. 396, p. 32, pl. 24, fig. 1, 1910; Arnold and R. Anderson, Bull. 398, p. 127, pl. 44, same figure, 1910; F. M. Anderson, Proc. Calif. Acad. Sci., Ser. 4, Vol. 3, p. 100, 1911; J. P. Smith, p. 176, 1912; Anderson and Martin, Vol. 4, p. 43, 1914.

Catinus scopulosus Conrad, Meek, Smithsonian Misc. Coll., No. 183, p. 31, 1864; Conrad, Amer. Journ. Conch., Vol. 1, p. 151, 1865.

Stomatia scopulosa Conrad, Meek, *op. cit.*, p. 31, 1864.

Sinum scopulosum Conrad, Meek, *op. cit.*, p. 32, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 114, 1868-9; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 12, 18, 91, 92, pl. 4, fig. 10, pl. 5, fig. 8, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 584, 588, 1913; English, Univ. Calif. Publ. Geol., Vol. 8, p. 211, 1914; Clark, Vol. 9, p. 15, 1915; Vol. 11, p. 169, pl. 22, fig. 8, 1918; Trask, Vol. 13, pp. 153, 154, 1922; Kew, U. S. Geol. Surv., Bull. 753, p. 78, 1924; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, pp. 327, 328, pl. 32, fig. 4, 1927.

Sinum planicostum Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 49, 78, pl. 14, fig. 6, 1868-9; Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 91, 92, 1909.

Sigaretus planicostum Gabb, Cooper, Calif. State Mining Bureau, Bull. No. 11, p. 80, 1896; Anderson, Proc. Calif. Acad. Sci., Ser. 3, Vol. 2, p. 204, 1905.

? *Sinum* (*Sigaretus*) *trigenarium* Trask, Univ. Calif. Publ. Geol., Vol. 13, pp. 139, 142, 146, 153, pl. 7, figs. 2*a*, 2*b*, 1922, *fide* Stewart, 1927.

Sinum californicum I. S. Oldroyd, Nautilus, Vol. 31, p. 13, 1917; Dall, U. S. Nat. Mus., Bull. 112, p. 165, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 19, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 130, pl. 92, figs. 13, 14, 1927.

Shell of moderate size, Naticoid, of about three rapidly enlarging whorls; body whorl large, aperture ample, ovoid, longest diameter at about an angle of 45° from axis of spire; outer lip simple, no obvious callus process on body whorl; sculpture consisting of spiral channels separating strap-like surfaces, the channels farther apart near the top of the body whorl, finer and closer together near the base; growth lines on the body whorl crossing spiral sculpture; suture distinct, obliquely abutting, sometimes nearly tangential near the apex of the spire. Diameter of body whorl, average, about 32 mm.

Oligocene: San Ramon formation of Contra Costa County (Clark).

Miocene: Empire formation of Oregon (Dall); San Pablo and Santa Margarita formations of middle California (Nomland).

Pliocene: Etchegoin formation of the Coalinga region (Nomland); lower "Fernando" of Los Angeles County (English); lower Pliocene of Elsmere Canyon and middle Pliocene of Pico and Holser canyons, Los Angeles County (H. R. G.); etc.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County (T. S. Oldroyd).

Recent: Monterey, California, to Todos Santos Bay, Lower California, Mexico (Dall, as *S. californicum*).

Sinum debile (Gould)

Sigaretus debilis Gould, Journ. Boston Soc. Nat. Hist., Vol. 6, p. 379, pl. 14, fig. 17, 1853; Carpenter, Proc. Zool. Soc. London for 1856, p. 207, 1856; Tryon, Man. Conch., Ser. 1, Vol. 8, p. 57, pl. 24, fig. 65, 1886; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 264, 1888; Keep, West Coast Shells, p. 47, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 316, 1903.

Sinum debile Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 165, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 131, pl. 92, figs. 3, 7, 1927.

Pliocene: San Diego well, San Diego (Cooper).
Pleistocene: Palisades north of Santa Monica (collection of F. C. Clark); rare in upper San Pedro series of Los Cerritos and of the lumber yard at San Pedro (Arnold).
Recent: Catalina Island, California, to Gulf of California, Mexico (Dall, 1921).

This species has a very flat shell, which is much smaller than mature shells of *scopulosum*. The shell is the opposite extreme from that of *Sinum perrini* (Arnold), a species of the Temblor formation (Miocene), coming from the head of Topanga Canyon, Los Angeles County, and having a peculiar, axially elongated shell very unlike that of other California Sinums. The Recent specimens of *Sinum scopulosum* (Conrad) were formerly erroneously classified in collections as *S. debile*, but the two species are entirely distinct.

Genus **AMAUROPSIS** Mörch, 1857

Amauropsis Mörch, Rink's Grønland, geographisk og statisk beskrevet, App., p. 81, 1857; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 89, 1909; Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 332, 1927; Woodring, Carnegie Inst., Publ. No. 385, p. 393, 1928.

Type (by subsequent designation, Dall, 1909), *Natica helicoides* Johnson (= ? *Nerita islandica* Gmelin), figured by Tryon, Man. Conch., Ser. 1, Vol. 8, p. 53, pl. 22, fig. 31, 1886, Arctic Ocean, Recent.

Shell axially elongate, imperforate, suture canaliculate, shell walls thin.

This is a northern cold and cool-water group not represented in the tropics. Woodring has shown that the tropical American species which have been sometimes assigned to *Amauropsis* belong to a different group, which he names *Pachycrommium*.[1]

Amauropsis oregonensis (Dall)

Ampullina (*Amauropsis*) *oregonensis* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 91, pl. 3, fig. 7, 1909.
Ampullina oregonensis Dall, Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, pp. 588, 590, 1913; Weaver, Univ. Wash. Publ. Geol., Vol. I, p. 30, 1916.

Oligocene: Blakeley formation of western Washington (Weaver).
Miocene: Empire formation of Coos Bay region, Oregon (Dall; Arnold and Hannibal).

Family VELUTINIDAE

Genus **VELUTINA** Fleming, 1821

Velutina Fleming, New Edinburgh Encyclopedia, American Edition, Vol. 13, Pt. 2, article on Mollusca, p. 684, Philadelphia, 1821; Gray, Proc. Zool. Soc. London for 1847, p. 156, 1847.
Galericulum Brown, Illust. Conch. Gt. Brit. Ire., pl. 38, figs. 35, 38, 1827.

Type (by original designation and absolute tautonymy), *Bulla velutina* Müller, Zoologia Danica, Ed. 3, Vol. 3, pl. 101, figs. 1-4, 1789, + *Velutina vulgaris* Fleming, = *Helix lævigata* of British authors, = *Helix lævigata* Linnæus.

Velutina lævigata (Linnæus)

Helix lævigata Linnæus, Syst. Nat., Ed. 12, p. 1250, 1767.
Galericulum lævigatum Linnæus, Brown, Illust. Conch. Gt. Brit. Ire., pl. 38, figs. 35, 38, 1827; Ed. 2, p. 23, pl. 19, figs. 35, 38, 1844.
Velutina lævigata Linnæus, Forbes and Hanley, Hist. Brit. Moll., Vol. 3, p. 347, pl. 99, figs. 4, 5, 1851; Sowerby, Conch. Man., Ed. 4, pl. 15, fig. 337, 1852; Fischer, Man. de Conchyl., p. 763, pl. 8, fig. 7, 1885.
Velutina lævigata Pennant, Tryon, Man. Conch., Ser. 1, Vol. 8, p. 65, pl. 27, figs. 41-44, 48, 59, 1886; Dall, Journ. Wash. Acad. Sci., Vol. 9, p. 2, 1919.
Velutina lævigata (Linnæus) Müller, Dall, U. S. Nat. Mus., Bull. 112, p. 167, 1921.

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[1] Type, by original designation (Woodring, *op. cit.*, p. 391, 1928) *Amaura guppyi* Gabb, figured by Woodring, pl. 31, figs. 7, 8; Miocene of Dominican Republic.

Pliocene: "Late Pliocene" of St. George Island, Pribilof group (Dall, 1919).
Recent: Icy Cape, Arctic Ocean, to Monterey, California; also Atlantic (Dall, 1921).

Tryon regarded *Helix lævigata* of Linnæus a "lost species," but he used the name as of Pennant (Brit. Zool., p. 140, pl. 86, fig. 139, 1777). "*Bulla*" *velutina* Müller (Zool. Dan., Prod., p. 242, 1776) may be a synonym. The synonymy of *lævigata* is large, but has been omitted from the above list of references.

The animal is entirely contained within the shell of this species, whereas in most of the other Pacific species the animal covers the shell. For this reason the epidermis of *lævigata* is rough and sometimes minutely spinose. *V. prolongata* Carpenter has a smooth, shiny epidermis made so by the animal entirely covering the shell.

In passing, it may be well to call attention to *Velutina rubra* Willett,[1] which appears to be a valid species overlooked by Dall and by Oldroyd in their catalogues of Recent shells of the Pacific coast of North America. It is a small species with a very inconspicuous spire. The living animal is of a bright vermillion color. There are four paratypes in Mr. Willett's collection, which is now on deposit in the Los Angeles Museum.[2]

Superfamily DOCOGLOSSA

Family LEPETIDAE

Genus LEPETA Gray, 1842

Lepeta Gray, Synop. Cont. Brit. Mus., Ed. 42, p. 148, 1840, *nomen nudum, fide* Sherborn, Index Anim.; Gray, Ed. 44, p. 67, 1842, diagnosis, no species, *fide* Iredale, Proc. Malac. Soc. London, Vol. 10, p. 306, 1913; Gray, Proc. Zool. Soc. London for 1847, p. 168, 1847, type *Patella cæca;* Dall, Amer. Journ. Conch., Vol. 5, p. 140, pl. 15, figs. 1, 1*a*, 1*b*, 1*c*, 1*d*, 1870; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, pp. 67, 68, 1891.

Type (by monotypy), *Patella cæca* Müller, Zool. Dan., Prod., p. 237, 1776, figured by Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 13, p. 68, pl. 40, figs. 29-32, 1891.

Shell patelliform, the embryonic nucleus spiral, lost in the adult; apex in front of the middle; no internal septum. Animal without external branchiæ; having the muzzle produced into a labial process on each side. Dental formula 2.0.1.0.2, the uncini narrow, erect, provided with cusps. (Pilsbry.)

Section CRYPTOBRANCHIA Middendorff, 1851

Cryptobranchia Middendorff, Reise Äuss. Norden und Ost. Sibiriens, Vol. 2, p. 183, 1851; Dall, Amer. Journ. Conch., Vol. 5, p. 143, 1870; Proc. U. S. Nat. Mus., Vol. 1, p. 334, 1878; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 13, pp. 67, 68, 1891.

Cryptoctenidia Dall, Proc. U. S. Nat. Mus., Vol. 54, p. 233, April 5, 1918, new name for *Cryptobranchia* Middendorff, not Gray, 1821.

Type (*fide* Dall, 1870), *C. concentrica* Middendorff.

Apex inclined forward, the anterior terminations of the muscle-scar not in front of it. Surface not granulate; color whitish. Apex of rhachidian tooth tricuspidate, the cusps nearly equal; uncini spatulate. (Pilsbry.)

Cryptobranchia was used by Gray before Middendorff proposed it as a generic name; but Gray's usage was applied to a higher classification and does not preoccupy the name in a generic sense.

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[1] Nautilus, Vol. 33, p. 25, July, 1919, type locality, Forrester Island, Alaska.

[2] The type specimen was sent by Mr. Willett to the Academy of Natural Sciences of Philadelphia but through some oversight no mention of it was made in the original description of the species.

Lepeta concentrica (Middendorff)

Patella (*Cryptobranchia*) *cæca*, var. *concentrica* Middendorff, Reise Äuss. Nord. Ost. Sibiriens, Vol. 2, p. 183, pl. 16, fig. 6, 1851, *fide* Dall, 1870.
"*Cryptobranchia concentrica* Dall ex Midd." Dall, Amer. Journ. Conch., Vol. 5, p. 143, pl. 15, figs. 2*a-g*, 1870.
Cryptobranchia alba Dall, *op. cit.*, p. 145, pl. 15, figs. 3*a-d*, 1870.
? Cryptobranchia instabilis Dall, *op. cit.*, p. 145, pl. 15, fig. 6, 1870.
Lepeta concentrica Middendorff, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 69, pl. 40, figs. 33-37, 1891.
Cryptoctenidia concentrica Middendorff, Dall, U. S. Nat. Mus., Bull. 112, p. 168, 1921.
Cryptoctenidia alba Dall, *op. cit.*, p. 168, 1921.
Cryptoctenidia alba instabilis Dall, *op. cit.*, p. 168, 1921.
Lepeta (*Cryptoctenidia*) *concentrica* Middendorff, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 142, 1927.
Lepeta (*Cryptoctenidia*) *alba* Dall, I. S. Oldroyd, *op. cit.*, p. 143, 1927.
Lepeta (*Cryptoctenidia*) *alba instabilis* Dall, I. S. Oldroyd, *op. cit.*, p. 143, 1927.

Pliocene or *Pleistocene:* Mouth of Elk River, Oregon, and one specimen from Cape Blanco, Oregon (collection at Stanford University).

Recent: Icy Cape, Arctic Ocean; on the west to Okhotsk Sea and Shantar Islands, on the east to Forrester Island, Alaska (Dall, 1921), Puget Sound (Oldroyd).

This shell varies greatly in shape. A series of Recent specimens convinces us that *alba* and *instabilis* are of no taxonomic importance whatsoever.

Specimens which Mr. Willett collected in Alaska at low tide line are stained a light greenish color, the deep-water shells being whitish. The fine radial striæ are apparent usually only on young or unworn individuals.

Lepeta magna (Dall)

Cryptoctenidia magna Dall, U. S. Geol. Surv., Prof. Paper 125-C, p. 30, pl. 5, fig. 1, 1920.

Pliocene: Center Creek, 1½ miles north of Nome, from the "second beach"; prospect holes in the "second beach," ¼ to ½ mile east of Nome; also Center Creek mines, 2 miles northwest of Nome, Alaska (Dall).

Family ACMAEIDAE

Shell patelliform, conical, the apex more or less anterior, the embryonic shell conical, not spiral. Animal having a free branchial plume above the neck on the left side; radula without median teeth. (Pilsbry.)

In addition to anatomical differences, the *Acmæidæ* differ from the *Lepetidæ* and *Patellidæ* by the more or less distinct internal border of the aperture. They are never iridescent within.[1]

Genus ACMAEA Eschscholtz in Kotzebue, 1830

Acmæa Eschscholtz, in Kotzebue, Neue Reise um die Welt in den Jahren 1823, '24, '25, and '26, Vol. 2, Appendix, p. 24; English translation, Vol. 2, Appendix, p. 350, London, 1830, genus without species (*fide* Woodring, 1928); Eschscholtz, in Rathke, Zool. Atlas, Pt. 5, p. 16, 1833; Dall, Amer. Journ. Conch., Vol. 6, p. 238, 1871; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 7, 1891; Woodring, Carnegie Inst., Publ. No. 385, p. 458, 1928.

Type (by subsequent designation, Dall, 1871), *Acmæa mitra* Eschscholtz.

This genus has a number of synonyms which have been given by Pilsbry (1891), hence, need not be repeated here.

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[1] The reader is referred to Pilsbry's excellent treatment of the family *Acmæidæ* in Volume 13 of Tryon's Manual of Conchology, 1891.

Acmæa mitra Eschscholtz in Rathke

Acmæa mitra Eschscholtz, in Rathke, Zool. Atlas, Pt. 5, p. 18, pl. 23, fig. 4, 1833; Dall, Amer. Journ. Conch., Vol. 6, p. 241, 1871; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 228, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 24, pl. 3, fig. 50, 1891; Keep, West Coast Shells, p. 99, fig. 85, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 318, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 168, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 144, pl. 85, fig. 5, 1927; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.

Acmæa mammillata Eschscholtz in Rathke, *op. cit.*, p. 19, 1833.

Acmæa marmorea Eschscholtz in Rathke, *op. cit.*, p. 19, 1833.

Pliocene: Upper Pliocene at Bath-house Beach, Santa Barbara (Berry).

Pleistocene: Santa Barbara to San Diego (Cooper); Crawfish George's, near San Pedro, "not uncommon" (Arnold); chiton bed on Point Firmin, Los Angeles County (Chace); at the old "coal mine" and other late Pleistocene localities on the west side of Point Loma, San Diego (Stephens).

Recent: Pribilof Islands, Bering Sea, to San Diego, California (Dall, 1921).

This is a large, white, variable shell easily distinguished from the other California species of *Acmæa*. Some specimens support a nodular growth of calcareous algæ, which mislead Eschscholtz into distinguishing them as *mammillata*. *Acmæa funiculata* Carpenter, 1864 (+ *tenuisculpta* Carpenter, 1866), generally treated as a variety of *Acmæa mitra*, may be a distinct species. It possesses axial ribs, of which there is not a trace on *A. mitra*.

Acmæa cassis Eschscholtz in Rathke variety **pelta** Eschscholtz in Rathke

Acmæa pelta Eschscholtz, in Rathke, Zool. Atlas, Pt. 5, p. 19, 1833; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 228, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 17, pl. 8, figs. 90, 91, 1891; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 319, 1903; Dall, Nautilus, Vol. 28, p. 14, June, 1914; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.

Acmæa (Collisella) pelta Eschscholtz, Dall, Amer. Journ. Conch., Vol. 6, p. 246, pl. 14, fig. 6, 1871.

Type locality: Sitka, Alaska, Recent.

Pleistocene: Santa Barbara (Cooper); Barlow's Ranch, near Ventura; rare in lower San Pedro series of Deadman Island; upper San Pedro series of Los Cerritos and San Pedro (Arnold); Point Firmin chiton beds (Chace); Pacific Beach, San Diego (Arnold); at the mouth of the abandoned "coal mine" and other localities on the west side of Point Loma, San Diego (F. Stephens).

Recent: Okhotsk and southern Bering Sea, Nushagak, Alaska, the Aleutian Islands, south to Rosario Bay, Lower California, and Socorro Island (Dall, 1921).

The radiating ribs of the variety *pelta* are not so well developed as those of the typical variety. Both forms occur on the same rock in Alaska, and it is likely that *pelta* should be synonymized.

Acmæa limatula Carpenter

Patella scabra Nuttall, Reeve, Conch. Icon., Vol. 8, *Patella*, pl. 37, figs. 119*a-b*, 1855, not of Gould, 1846.

Acmæa scabra, Nutt., var. *limatula* Carpenter, Amer. Journ. Conch., Vol. 2, p. 340, 1866.

Acmæa scabra Nuttall, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 228, 1888; not *A. scabra* (Gould).

Acmæa scabra Reeve, var. *limatula* Carpenter, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 14, pl. 3, figs. 38-40, 1891.

Acmæa limatula Carpenter, Dall, Nautilus, Vol. 28, p. 14, 1914; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 170, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 19, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 152, 1927; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 253, 254, 1929.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro (T. S. Oldroyd); at the Point Firmin chiton bed (Chace), Los Angeles County; at the mouth of the abandoned "coal mine" and various other localities on the west side of Point Loma, also south of La Jolla, San Diego (Stephens).

Recent: Crescent City, California, south to Cedros and Socorro islands, Lower California, Mexico (Dall, 1921).

Acmæa scabra (Gould)

Patella (Lottia ?) scabra Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 152, 1846.

Patella spectrum Nuttall, Reeve, Conch. Icon., Vol. 8, *Patella*, pl. 29, figs. 76*a-b*, 1855.

Acmæa spectrum Nuttall, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 228, 1888; Keep, West Coast Shells, p. 100, figs. 86, 87, 1888, 1892; West American Shells, p. 230, fig. 252, 1904; Ed. 2, p. 216, fig. 209, 1911.

Acmæa spectrum (Nuttall) Reeve, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 320, 1903.

Acmæa spectrum Reeve, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 14, pl. 1, figs. 7, 9, 1891.

Acmæa scabra Gould, Dall, Nautilus, Vol. 28, p. 14, 1914; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 170, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 19, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 153, 1927; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.

Pleistocene: Santa Barbara and San Pedro (Cooper); rare in lower San Pedro series of Deadman Island and rather common in the upper San Pedro series of Deadman Island and San Pedro (Arnold); lower San Pedro series of Nob Hill cut, San Pedro (T. S. Oldroyd); in the chiton bed at Point Firmin (Chace), Los Angeles County; at the mouth of the old "coal mine" and other nearby localities on the west side of Point Loma, San Diego (Stephens).

Recent: San Francisco, California, to Socorro Island, Lower California, Mexico (Dall, 1921); Puget Sound (collection of Fred Baker).

The prominent, rugose radiating ribs of this common Recent species serve to distinguish it from most other Pacific coast limpets.

Acmæa persona Eschscholtz in Rathke

Acmæa persona Eschscholtz, in Rathke, Zool. Atlas, Pt. 5, p. 20, pl. 24, figs. 1, 2, 1833; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 228, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 15, pl. 2, figs. 25-28, pl. 3, figs. 51-56, 1891; Dall, Nautilus, Vol. 28, p. 14, 1914; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1921; Dall, U. S. Nat. Mus., Bull. 112, p. 170, 1921; not of Carpenter, 1864.

Pleistocene: At the fossil chiton bed on Point Firmin, Los Angeles County (Chace).

Recent: Shumagin Islands, Alaska, to Socorro Island, Lower California, Mexico (Dall, 1921).

Pilsbry has given a number of synonyms of this species.

Acmæa insessa (Hinds)

Patella insessa Hinds, Ann. Mag. Nat. Hist., Ser. 1, Vol. 10, p. 82, pl. 6, fig. 3, 1842.

Nacella incessa Hinds, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 650, 1864; Keep, West Coast Shells, p. 103, fig. 91, 1888, 1892.

Acmæa insessa Hinds, Dall, Amer. Journ. Conch., Vol. 6, p. 244, pl. 14, fig. 3, April 4, 1871; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 227, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 18, pl. 6, figs. 36, 37, 1891; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 318, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 170, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 19, 1925; F. Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, pp. 253, 254, 1929.

Acmæa incessa Hinds, Keep, West American Shells, p. 234, fig. 258, 1904; Revised Ed., p. 220, fig. 215, 1911; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 156, 1927.

Type locality: San Diego, California, "on sea-weed."

Pliocene: Upper Pliocene at the Bath-house Beach outcrop, Santa Barbara (Arnold).

Pleistocene: "Pliocene" of Deadman Island; lower San Pedro series of Deadman Island and San Pedro (Arnold); lower San Pedro series of Nob Hill cut, San Pedro (T. S. Oldroyd); upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, and Crawfish George's (Arnold); at the Point Firmin chiton bed (Chace); Spanish Bight (Arnold) and on west side of Point Loma (Stephens), San Diego.

Recent: Trinidad, California, to Magdalena Bay, Lower California, Mexico, on kelp (Dall, 1921).

Acmæa asmi (Middendorff)

Patella (*Acmæa*) *asmi* Middendorff, Bull. Phys. Math. Acad. Imp. Sci. St. Pétersb., Vol. 6, p. 318, November, 1847
Patella asmi Middendorff, Beitr. Malac. Rossica, Vol. 1, Pt. 2, p. 39, pl. 1, fig. 5, 1849.
Collisella asmi Middendorff, Dall, Amer. Journ. Conch., Vol. 6, p. 252, pl. 14, fig. 7, 1871.
Acmæa asmi Middendorff, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 19, pl. 6, figs. 38, 39, 1891; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 170, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 157, pl. 94, figs. 15, 16, 1927.

Pleistocene: At the chiton bed on Point Firmin, Los Angeles County (Chace).
Recent: Sitka, Alaska, to San Diego, California, and Socorro Island, Mexico, "on black Tegulas" (Dall, 1921).

Acmæa depicta (Hinds)

Patelloida depicta Hinds, Ann. Mag. Nat. Hist., Ser. 1, Vol. 10, p. 82, pl. 6, fig. 4, 1842; Zool. Voy. Sulphur, p. 53, 1844.
Nacella depicta Hinds, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 650, 1864.
Collisella (?) *depicta* Hinds, Dall, Amer. Journ. Conch., Vol. 6, p. 254, 1871.
Acmæa depicta Hinds, Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 13, p. 19, pl. 6, figs. 40, 41, 1891; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 317, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 170, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 157, 1927.

Type specimen: In the British Museum ?

Type locality: San Diego, California; Recent.

Pleistocene: Upper San Pedro series at Crawfish George's, "one specimen" (Arnold), Los Angeles County.
Recent: Santa Barbara, California, to Lower California, Mexico, "on *Zostera*" (Dall, 1921).

This is a small, narrow, elongate species that lives on sea weed. The direct influence of habitat on the shape of the shells of the *Acmæidæ* is so great that probably many forms of distinctive appearance and separate names are mere ecologic variants. *A. depicta* has brown bands radiating from the apex. It is similar to *A. paleacea* Gould, but the latter form is much narrower and lacks the radial brown color bands of *depicta*. *A. triangularis* (Carpenter) has bright radiating color bands and is much larger and rounder than either.

Acmæa paleacea Gould

Acmæa paleacea Gould, Mex. and Calif. Shells, p. 3, pl. 14, fig. 5, 1851; Boston Journ. Nat. Hist., Vol. 6, p. 376, pl. 14, fig. 5, 1853; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 13, p. 20, pl. 6, fig. 42, 1891; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 319, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 171, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 158, 1927.
Collisella paleacea Gould, Dall, Amer. Journ. Conch., Vol. 6, p. 253, 1871.

Pleistocene: Upper San Pedro series of Crawfish George's, Los Angeles County, "two specimens found" (Arnold).
Recent: Trinidad, California, to Lower California, Mexico, on *Zostera* (Dall, 1921).

Acmæa rudis Gabb

Acmæa rudis Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 51, 87, pl. 14, fig. 9*a*, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 228, 1888.
"*Acmæa*" *rudis* Gabb, Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 313, pl. 32, figs. 11, 11*a*, 1927.

Type specimen: In the Whitney Collection, Museum of Comparative Zoology, Harvard University.

Type locality: "Pliocene of San Fernando, near Wiley's."

Pliocene: At the type locality (Gabb; Cooper).

Stewart, who carefully studied Gabb's types of California fossil mollusks, was unable to recognize the muscle scar as shown by Gabb, and it is possible that this species is a *Calyptræa* or a *Crucibulum*. If so, the species would require a new specific name, unless, of course, Gabb's form is conspecific with some other already named species.

Acmæa instabilis (Gould)

Plate 32, Figure 32

Patella instabilis Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 150, 1846.

Nacella instabilis Gould, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 650, 1864; Keep, West Coast Shells, p. 103, 1888, 1892.

Acmæa instabilis Gould, Dall, Amer. Journ. Conch., Vol. 6, p. 245, 1871; Pilsbry, in Tryon's Man. Conch., Ser. 1, Vol. 13, p. 18, pl. 6, figs. 32, 33, 1891; Cooper, Calif. State Mining Bureau, Bull. 4, Pt. 3, p. 24, 1894; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 318, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 170, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 156, pl. 94, figs. 1, 2, 1927.

Type specimen: In the New York State Museum, Albany, No. 6,356, *fide* Oldroyd.

Type locality: Neah Bay, Washington; Recent.

Pleistocene: Upper San Pedro series at Crawfish George's, near Fort McArthur, Los Angeles County, one specimen (Arnold); questionably at San Nicholas Island (Cooper, as of Bowers); upper Pleistocene at S. D. S. N. H. loc. 74, southwest of Goleta, Santa Barbara County (U. S. G.).

Recent: Kodiak Island, Alaska, to San Pedro, California (Dall, 1921); San Diego (collection of Fred Baker).

The habitat of this species on the large stalks of kelp accounts for the elongate oval shape, with the basal margins at each end turned up.

Superfamily RHIPIDOGLOSSA

Family PHASIANELLIDAE

Shell bulimiform or subglobose, polished, without epidermis or nacre, variegated with bright colors; operculum heavy, calcareous, internally paucispiral, with nucleus near the basal margin, externally convex, white. (Pilsbry, 1888.)

Genus TRICOLIA Risso, 1826

Tricolia Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 122, 1826; Gray, Proc. Zool. Soc. London for 1847, p. 144, 1847, misspelled "*Tricolea*"; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 167, 1888; Woodring, Carnegie Inst., Publ. No. 385, p. 418, 1928.

Type (by subsequent designation, Gray, 1847), *Turbo pullus* Linnæus, figured by Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 168, pl. 38, figs. 56-60, 1888, European Seas, including the Mediterranean, Recent.

In a recent paper, Woodring (1928) has completely separated *Tricolia* Risso from *Phasianella* Lamarck, placing the former in a distinct family, *Tricoliidæ*. As the basis of separation is largely one of great difference in the sizes of the respective genotypes, the two genera are here retained in the one family. The type of *Phasianella* Lamarck,[1] according to Woodring,[2] is *Buccinum australe* Gmelin, which is a giant in comparison with the California Recent and fossil species that have been called *Phasianella*, and it appears natural to make a generic distinction in this case.

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[1] Ann. Mus. Hist. Nat. Paris, Vol. 4, p. 295, 1804.

[2] See Woodring's discussion of the designation of the type of the genus. *Phasianella australis* (Gmelin) is a Recent species of Australia. It is figured by Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 164, pl. 37, figs. 22-28, pl. 38, fig. 46, 1888.

Tricolia compta (Gould)

Phasianella compta Gould, U. S. House of Representatives, Document 129, Prelim. Rept., p. 25, 1855; U. S. Pacific R. R. Repts., Vol. 5, p. 11, figs. 25, 26, 1857; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 258, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 321, 1903; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Phasianella (Tricolia) compta Gould, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 173, pl. 39, fig. 69, 1888; Dall, U. S. Nat. Mus., Bull. 112, p. 171, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 161, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Phasianella (Tricolia) compta Gould, variety *producta* Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 256, 1908; Strong, Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 191, pl. 10, fig. 1, 1928.

Tricolia compta producta Dall, U. S. Nat. Mus., Bull. 112, p. 172, 1921.

Pleistocene: "Saugus" formation near Ventura (Waterfall); lower San Pedro series at San Pedro and Deadman Island; common in upper San Pedro series of San Pedro, Los Angeles County; foot of Twenty-sixth Street, San Diego (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to Gulf of California, Mexico (Dall, 1921).

Mr. A. M. Strong suggests that Arnold's Pleistocene records may refer to *pulloides* (Carpenter). *T. compta* is an inhabitant of bays and lagoons. It is larger than *T. pulloides*, which occurs along the open coast in tide pools and on sea lettuce.

Tricolia pulloides (Carpenter)

Phasianella compta Gould, ? var. *pulloides* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 651, 1864.

Phasianella (? compta, var.) pulloides Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 180, March, 1865.

Phasianella compta Gould, var. *pulloides* Carpenter, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 173, pl. 39, fig. 70, 1888.

Tricolia pulloidea Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 172, 1921.

Phasianella pulloides Carpenter, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Phasianella (Tricolia) pulloides Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 162, 1927; Strong, Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 192, pl. 10, figs. 5, 6, 7, 1928.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to Lower California, Mexico (Dall).

Most of the individuals of *Tricolia pulloides* that are commonly found in some places along the southern California coast on sea lettuce are immature, the adults living in deeper water. The species has a smaller shell than *compta*, adults averaging about five millimeters in length, whereas *compta* is often over 8 millimeters.

Section EULITHIDIUM Pilsbry, 1898

Eucosmia Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 475, June, 1864; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 177, 1888; not *Eucosmia* J. F. Stephens, Illust. Brit. Ent., p. 265, 1831, *Lepidoptera*.

Eulithidium Pilsbry, Nautilus, Vol. 12, p. 60, September, 1898, new name for *Eucosmia* Carpenter, 1864, not Stephens, 1831; Index to Tryon's Man. Conch., in Vol. 17, p. 319, under *Eucosmia*, October, 1898, *fide* p. 348; Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 255, 1908.

Type (by subsequent designation, Pilsbry, 1888), *Eucosmia variegata* Carpenter, (not *P. variegata* Lamarck), + *Tricolia substriata* (Carpenter), variety *typica* (Dall).

Shell solid, shining, variegated, not nacreous; aperture and whorls rounded; conspicuously umbilicated; peritreme scarcely continuous, not callous. (Carpenter.)

Tricolia substriata (Carpenter)

Eucosmia (? variegata, var.) substriata Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 475, June, 1864.

Phasianella (Eucosmia) variegata Carpenter, var. *substriata* Carpenter, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 177, no figure, 1888.

Eulithidium substriatum Carpenter, Berry, Nautilus, Vol. 21, p. 45, 1907; Dall, U. S. Nat. Mus., Bull. 112, p. 172, 1921.

Phasianella substriata Carpenter, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.
Phasianella (*Eulithidium*) *substriata* Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 163, 1927.

Type locality: Cape San Lucas, Lower California, Mexico; Recent.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Catalina Island, California, to Panama (Dall); Monterey Bay, California (Berry).

Tricolia variegata (Carpenter)

Eucosmia variegata Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 13, p. 475, June, 1864; not Berry, Nautilus, Vol. 21, p. 45, 1907; not *Phasianella variegata* Lamarck.
Phasianella (*Eucosmia*) *variegata* Carpenter, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 177, no figure, 1888.
Eulithidium typicum Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 255, June 16, 1908, new name for *Eucosmia variegata* Carpenter, not *Phasianella variegata* Lamarck; Dall, U. S. Nat. Mus., Bull. 112, p. 172, 1921.
Phasianella (*Eulithidium*) *typica* Dall, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 162, (not pl. 91, fig. 9, = *P. rubrilineata* Strong, 1928) 1927; Strong, Proc. Calif. Acad. Sci., Ser. 4, Vol. 17, p. 194, pl. 10, figs. 12, 13, 1928.

Type locality: Cape San Lucas, Lower California, Mexico.

Recent: Magdalena Bay to Cape San Lucas, Lower California, Mexico (Strong, 1928).

This species is the genotype of *Eulithidium* Pilsbry. It is a smooth shell somewhat similar to *pulloides* but has an open umbilicus. The paper by Strong above referred to will be found very helpful in distinguishing the California Recent species.

As pointed out by Woodring[1], Dall's name is unnecessary if *Tricolia* is separated generically from *Phasianella*.

Family TURBINIDAE

Shell turbinate or trochiform, solid, pearly within, smooth or sculptured without; operculum calcareous, heavy, circular or elongated, flat, and covered with a thin horny layer within, convex, calcareous and smooth or rugulose outside; the opercular nucleus multispiral, subcentral, or marginal.

The *Turbinidæ* differ from the *Trochidæ*, particularly in the possession of a calcareous operculum, and also in other characters. The *Phasianellidæ* do not have a nacreous shell within.

In general, the *Turbinidæ* are inhabitants of tropical and temperate seas in the littoral zone or at shallow depths. They are herbivorous.

Genus TURBO Linnæus, 1758

Turbo Linnæus, Syst. Nat., Ed. 10, p. 761, 1758; Montfort, Conchyl. Syst., Vol. 2, pp. 202-204, 1810, type *T. petholatus;* Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, pt. 2, p. 191, 1888; Woodring, Carnegie Inst., Publ. No. 385, p. 408, 1928.
Senectus Swainson, Treat. Malac., p. 348, 1840, as of Humphrey.
Læviturbo Cossmann, Ess. Paléo. Comp., Vol. 11, p. 118, 1918, type, *T. petholatus* Linnæus.

Type (by subsequent designation, Montfort, 1810), *Turbo petholatus* Linnæus, Indo-Pacific; Recent.

Shell large or moderate in size, turbinate; whorls rounded, smooth, or ribbed, spinose or carinated, umbilicate or imperforate; aperture subcircular, more or less produced at base. Operculum circular, with subcentral nucleus; outside convex, granulate, or smooth, not spiral nor ribbed. (Pilsbry.)

As pointed out by Woodring, *Turbo marmoratus* Linnæus has generally been considered the type of the genus because it was the species chosen by Lamarck in the Prodrome as an example of *Turbo*. Since Lamarck's selections of examples in this work are not considered type designations, Montfort's choice of *Turbo petholatus* Linnæus is the earliest valid selection.

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[1] Woodring, Carnegie Inst. Wash., Publ. No. 385, p. 420, 1928.

Subgenus **CALLOPOMA** Gray, 1850

Callopoma Gray, Figs. Moll. Anim., Vol. 4, p. 87, 1850; Pilsbry, Tryon's Man. Conch., Vol. 10, p. 210, 1888; Cossmann, Ess. Paléo. Comp., Vol. 11, p. 116, 1918.

Type, Turbo fluctuatus Gray, *fide* Cossmann, 1918.

Shell turbinate, imperforate, dark colored; aperture round; face of the columella with a deep longitudinal groove. Operculum circular, with a subcentral apex; outside convex, granulose, with a deep central pit and a marginal cordon of granulose ribs, separated by narrow, deep concentric grooves. (Pilsbry.)

It seems probable that the *Turbo fluctuatus* of Gray is the *Turbo fluctuosus* Wood, 1828. Sherborn[1] suggests such a synonymy and it is certain that the *Turbo fluctuatus* of Reeve refers to Wood's species.

Turbo (Callopoma) fluctuosus Wood

Turbo fluctuosus Wood, Index Testac., Supplement, pl. 6, fig. 44, 1828; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 11, *Turbo*, p. 61, pl. 9, fig. 2, pl. 17, fig. 2, pl. 34, fig. 1 (?), 1873; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, pp. 150, 152, 1924; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

? *Trochus fokkesi* Jonas, in Philippi, Abbild. Beschreib., Band 1, *Trochus*, p. 5, pl. 2, figs. 1, 10 (operculum), 1843.

Turbo fluctuatus Reeve, Conch. Icon., Vol. 4, *Turbo*, sp. 34, pl. 8, fig. 34, March, 1848.

Callopoma fluctuata Gray, Figs. Moll. Anim., Vol. 4, p. 87, 1850.

Turbo (*Callopoma*) *fluctuosus* Wood, Mabille, Bull. Soc. Philomathique de Paris, Ser. 8, Vol. 7, p. 56, 1895; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 238, 1909.

Turbo fluctuatus Gray, Cossmann, Ess. Paléo. Comp., Vol. 11, p. 116, pl. 3, fig. 13, 1918.

Shell ovate-conic, short, solid, imperforate, olivaceous, green, brown or grayish, longitudinally strigate or tesselate with white; spire conic; whorls five, generally angulate and nodose at shoulder, with a varying number of coarse subnodose revolving carinæ and of intermediate liruIæ upon the median and lower portions of the body whorl; aperture large, iridescent within; columella wide, white, slightly produced at the base, and with a longitudinal excavation or groove upon its face. Alt. 58, diam. 65 mill. (Pilsbry.)

Pliocene: Coronados Island, Gulf of California, Mexico (Hanna and Hertlein).

Pleistocene: Lower Quaternary, Magdalena Bay, and upper Quaternary of Scammons Lagoon, Lower California, Mexico (Jordan).

Recent: Cedros Island, Lower California, and Gulf of California, Mexico, to Peru.

This shell is noticeably variable in color and intensity of sculpturing. In the more strongly nodose forms it approaches the coronated variety *saxosus*. The operculum is flat and covered with a thin chestnut horny layer on the inside; externally it has an elevated spiral granulose rib with four or five parallel marginal rows of fine, comb-like tubercles.

Turbo (Callopoma) fluctuosus Wood variety **saxosus** Wood

Turbo saxosus Wood, Index Testac. Supplement, pl. 6, fig. 45, 1828; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 11, p. 23, pl. 15, fig. 2, pl. 16 bis, fig. 2, 1873; Hanna and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

? *Turbo fluctuosus* Wood, in part only, of Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 11, *Turbo*, pl. 16, figs. 1, 2 (?), also 16 bis, figs. 1, 2, 1873.

Turbo (*Callopoma*) *saxosus* Wood, Dall, U. S. Nat. Mus., Vol. 37, p. 238, 1909.

Pliocene: Coronados Island, Gulf of California, Mexico (Hanna and Hertlein).

Recent: Mazatlan, Mexico, and south to Paita, Peru, and the Galapagos Islands (Dall).

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[1] Index Animalium, Part 2, "Turbo, ? Wood, 1828." We have not seen the volume IV of Gray's work above referred to.

This variety is carinated, usually nodose at the shoulder and with a series of erect tubercles below the suture.

Turbo topangensis Arnold, of the Temblor formation, lower part of the Monterey group, recalls *Tectarius dilatatus* d'Orbigny of the Recent fauna of Cuba, but it attains a larger size than the Cuban shells. It is quite unlike *Tectarius galapagiensis* Stearns[1] of the tropical fauna.

Genus ASTRAEA Bolten, 1798

Astræa Bolten, Mus. Boltenianum, Pt. 2, p. 79, 1798; Suter, Man. New Zealand Moll., p. 166, 1913; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 92, April, 1909; Woodring, Carnegie Inst., Publ. No. 385, p. 412, 1928.

Type (by subsequent designation, Suter, 1913), *Trochus imperialis* Gmelin (= *Trochus heliotropium* Martyn); Recent, New Zealand.

Shell trochiform, generally depressed, flattened below; with or without an open umbilicus; basal periphery of whorls generally carinated, always so in the young; operculum calcareous, oval, or oblong, nucleus generally submarginal or terminal, multispiral, exterior almost smooth to coarsely ribbed. Size, up to several inches in diameter.

Geologic range: Early Tertiary to Recent (*Astræa, s. l.*).

Woodring has shown that *Astralium* Link[2] can be used as a section for the West Indian Astræas which have a narrow umbilicus or are entirely imperforate. The type of *Astræa*[3] is widely umbilicate.

The "*Astræa* Gmelin," 1789, of Agassiz in the Nomenclator Zoologicus (Fasc. 12, p. 38, 1847) is an error.

Subgenus ASTRAEA, s. s.

Umbilicus open; basal periphery of whorls carinated; operculum with eccentric nucleus, exterior smooth.

The typical subgenus is not represented on the North American coast.

Subgenus POMAULAX Gray, 1850

Pomaulax Gray, Fig. Moll. Anim., Vol. 4, p. 87, 1850; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, pp. 187, 190, 1888.

Type, Trochus undosus Wood.

Shell large, conic, solid, imperforate; periphery carinated; base flattened; umbilical tract with a strong, curved rib; operculum obovate, narrower toward the proximal extremity, nucleus terminal, outside with four strong granulose ribs radiating from the nucleus. (Pilsbry.)

This subgenus is readily distinguished from *Astræa, s. s.*, by its imperforate axis, whereas the typical subgenus is widely umbilicate. *Pachypoma* Gray differs in its long and very convex operculum and the absent or very obscure semicircular rib in the umbilical region. The oblong, strongly ribbed,[1] and partly granulose operculum of *A. undosa* is very different from the comparatively small, elongate, smooth, convex operculum of *A. inæqualis* (Martyn), the type of *Pachypoma*. *Uvanilla* Gray has fewer ribs on the outer surface of the operculum. This latter group is represented in the southern fauna by *Astræa* (*Uvanilla*) *olivacea* (Wood), *buschi* (Philippi), and *unguis* (Wood).

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[1] Nautilus, Vol. 8, p. 87, 1892; Proc. U. S. Nat. Mus., Vol. 16, p. 396, pl. 51, fig. 7, 1893.

[2] Beschreib. Natur.-Sammlung Univ. Rostock, p. 135, 1807, type, *Astralium deplanatum* Link (= *Trochus costulatus* Lamarck), designated by Woodring, 1928.

[3] Hedley (Mem. Australian Mus., Vol. 4, p. 335, 1903) sought to supplant *Astralium* Link with *Calcar* Montfort on the basis that Link's work was not properly published. This interpretation cannot be accepted.

Astræa (Pomaulax) undosa (Wood)

Plate 31, Figures 6*a*, 6*b*, 7

Trochus undosus Wood, Index Testac., Supplement, p. 16, pl. 5, fig. 1, 1828.

Pomaulax undosus Wood, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 651, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 83, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 260, 1888; Keep, West Coast Shells, p. 89, fig. 75, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 199, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 322, 1903; Keep, West American Shells, p. 237, 1904.

Imperator undosa Wood, Tryon, Struct. Syst. Conch., Vol. 2, p. 308, pl. 88, fig. 33, 1883.

Astralium (*Pomaulax*) *undosum* Wood, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 243, pl. 58, figs. 69, 70, 1888.

"*Pachypoma inæquale* Martyn," Williamson, Proc. U. S. Nat. Mus., Vol. 15, pl. 23, figs. 1, 5 (not fig. 3), 1892, not of Martyn.

Astræa undosa Wood, Dall, Nautilus, Vol. 32, p. 24, 1918; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 149, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Astræa (*Pomaulax*) *undosus* Wood, Dall, U. S. Nat. Mus., Bull. 112, p. 172, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 164, pls. 102, 103, 1927.

Shell large, conic; whorls about six, periphery with a prominent undulating nodose carina; base flattened, with five or six spiral ribs; aperture elongate-ovate, oblique, somewhat pearly within; columella arched, between which and the prominent spiral ridge in the umbilical region there is a crescentic depression; outer lip simple; sculpture consisting of undulating, somewhat nodose ribs, slanting approximately parallel to the slope of the left side of the spire, and also a prominent nodose, pre-sutural carina; in living specimens shell colorless or gray, covered with a horny, obliquely lamellose epidermis; operculum obovate, very slightly convex inside, with a terminal nucleus, outside with three (four or five, counting one or both raised margins) radiating, raised, granulose ridges. Large specimens measure: greatest diameter of base 140 mm., axial length 80 mm.

Pleistocene: Santa Barbara to San Diego (Cooper); upper San Pedro series at San Pedro and Crawfish George's, Los Angeles County, and of Pacific Beach, San Diego (Arnold); Magdalena Bay, Lower California (Dall, 1918; Jordan, 1924, as "Lower Quaternary"); upper Pleistocene at San Quintin Bay, Lower California (Jordan, 1926).

Recent: Laguna Beach, Orange County, southern California, to Cedros Island, Lower California (Dall, 1921); ? San Pedro (Williamson—figured specimen fossil ?); more northern reports by Cooper, Arnold, and others questionable.

This species has not been reported in beds older than the faunal break at the end of the Pliocene. Perhaps *gradata* changed over into *undosa* at that time.

Astræa (Pomaulax) gradata, new species

Plate 31, Figures 1*a*, 1*b*, 3*a*, 3*b*, 5, 8, 9

? *Pachypoma* sp. Watts, Bull. 19, Calif. State Mining Bureau, p. 322, 1900; Eldridge and Arnold, Bull. 309, U. S. Geol. Survey, p. 24, 1907.

Shell large, eccentrically conical, apical angle about 60°; whorls convex, about seven, subtabulate, the top of each whorl strongly abutting against the lowest, somewhat nodular ridge or carina of the preceding whorl, thence extending out nearly horizontally about 8 mm. to the first row of nodes; below the uppermost row of nodes the surface sloping downward at an angle of about 45° past the middle of the whorl to the second row of nodes, where it drops off nearly vertically for about 6 mm. to the basal ridge; each vertical segment of the surface, especially the lowest, given a concave appearance by the projection of the spirally aligned nodes or ridges; upper nodes elongated obliquely, somewhat comma or crescent shaped, pointing forward and downward, 14 to a whorl; nodes of the second row, which are about as far below the center of the whorl as the upper row is above, somewhat more numerous and coalescing laterally to form a spiral ridge; basal ridge analogous to the strongly nodose keel of *Astræa undosa* (Wood) but showing very little tendency to be nodose and not projecting beyond the second row of nodes; lower two ridges showing through as sharp angles on the cast, the upper row of nodes as faint undulations along a rounded shoulder; sutures distinctly impressed; base nearly flat, sculptured by three strong spiral ridges besides the basal ridge or carina on the angle of the whorl, which appears below much like the other spiral ridges of the base; inner lip covered with a fairly heavy callus; outer lip in every case missing, but the growth lines on the side of the whorl, which slope backward at an angle of about 45° and cross the upper row of nodes diagonally, showing the aperture to be like that of *Astræa undosa*. Operculum similar to that of *undosa*, but less elongate.

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[1] There are three prominent ribs radiating from the nuclear extremity, but the proximal margins are elevated, one or both of which might be counted as ribs, giving a count of four or five.

Dimensions: Altitude 75 mm., diameter of body whorl 65 mm., height of body whorl 35 mm.

Type specimen: Holotype No. 286, San Diego Society of Natural History.

Type locality: Southeast of Pico Canyon, Los Angeles County, middle Pico Pliocene (H. R. G.).

Pliocene: S. D. S. N. H. locality 228, southeast of Pico Canyon, Los Angeles County, the type specimen; loc. 217, Holser Canyon, Los Angeles County, one operculum; loc. 217*a*, nearby, two small specimens and a small operculum; loc. 217*b*, one figured paratype and the figured operculum, with three other specimens and three other opercula (coll. by H. R. G.); the forms identified by Merriam and listed by Watts came from localities not far from locality 217.

Astræa gradata is distinguished from *A. biangulata* Gabb[1] by the fewer number of nodes per whorl (14 as a maximum in the upper row instead of 22 or more); by the prominent upper angle and tabulation, the upper row of nodes being only slightly drawn out and not so much like axial ribs as in *biangulata;* by the basal carina, which is practically continuous and shows almost no tendency to be nodose; and by the absence of the minor spiral line shown in *biangulata* between the lower two rows of nodes. It is probable that "*Astralium*" *raymondi* Clark is only a small form of *biangulata,* since they both come from the same beds; and *Calliostoma bicarinatum* Clark may be a very young form, since it also occurs in the same localities and is analogous in form to the young of *A. gradata.*

This new species is distinguished from *Astræa* (*Pomaulax*) *turbanica* (Dall)[2] of the Recent southern fauna by its larger size, its much less prominent and less rib-like upper row of nodes, and the more laterally elongate lower row of nodes. Also, *A. turbanica* has a much flatter base, which is more clearly set off from the lateral surface of the body whorl by the prominent nodose basal carina.

The operculum, several specimens of which were found close to the shells, is of interest in showing that this species and also probably the closely related *biangulata* Gabb from the upper Miocene belong to the subgenus *Pomaulax.*

The name *gradata* refers to the step-like appearance of the cone, which is due to the steep slope of the whorls above the suture and the gentle slope below.

Astræa (Pomaulax) breaensis Carson

Astræa breaensis Carson, Bull. So. Calif. Acad. Sci., Vol. 25, pt. 2, pp. 57, 58, pl. 4, figs. 3, 4, May 31, 1926.

Type specimen: No. 116 in the type collection at Stanford University.

Type locality: Mouth of Brea Canyon, Puente Hills, Orange County, California; Pliocene.

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[1] Geol. Surv. Calif., Palæo., Vol. 2, p. 15, 1866, p. 83, pl. 3, fig. 26, 1868-9, figured also by Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 318, pl. 32, fig. 6, 1927.

[2] *Pomaulax turbanicus* Dall, Nautilus, Vol. 23, p. 134, 1910, 36 fathoms, Magdalena Bay, Lower California. See Plate 31, figure 2, showing Dall's type specimen.

"Shell small, conical, spire low, whorls about four; whorls sloping above, rounded on the sides and base, suture distinct, appressed; sculpture consisting of prominent rounded oblique ridges, about twenty on body whorl, with narrow interspaces, extending from the side of the whorl to the suture above; base of body whorl marked by four heavy, rounded, spiral ridges with narrower interspaces; aperture of moderate size, subcircular, outer lip simple, inner lip slightly thickened, umbilicus false. Height of type, 22 mm., maximum diameter of type, 41 mm., minimum diameter of type, 35 mm."

Pliocene: Fernando (lower or middle Pliocene) of Brea Canyon, Orange County, California.

This species is quite distinctive, on account of its low spire, long protractive ribs, and the convex base of the body whorl.

"Astralium" arnoldi Nomland is a *Tegula,* a member of the family *Trochidæ.*

Subgenus **PACHYPOMA** Gray, 1850

Pachypoma Gray, Figures of Molluscous Animals, Vol. 4, p. 88, 1850; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 244, 1888; Stewart, Proc. Acad. Nat. Sci., Phila., Vol. 78, p. 318 and footnotes, 1927.

Type (by subsequent designation, Pilsbry, 1888), *Trochus inæqualis* Martyn.

Shell similar to that of *Pomaulax,* but umbilical area scarcely ribbed and operculum small, externally very convex, white, and smooth, with a broad, central convexity and obscure, narrow side ribs.

Astræa (Pachypoma) inæqualis (Martyn)

Plate 31, Figures 4*a*, 4*b*, 10

Trochus inæqualis Martyn, Universal Conchologist, Vol. 1, pl. 31, table, 1784, not of Gmelin, 1793.

Trochus gibberosus Pfeiffer, Krit. Regist. Mart. Chemn. Conch. Cab., p. 102, 1840, after Chemnitz, Vol. 10, p. 286, Vignette 23 A, B, 1788.

Pachypoma gibberosum Chemnitz, Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 256, 1888.

Astralium (*Pachypoma*) *inequale* Martyn, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 244, pl. 57, figs. 1, 5, 1888.

Pachypoma inæquale Martyn, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 199, pl. 19, figs. 4, 5, opercula, pl. 23, fig. 3, = variety *depressum* Dall, not pl. 23, figs. 1, 5, which represent *undosa* (Wood); Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 321, 1903.

Astræa (*Pachypoma*) *precursor* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 93, pl. 6, figs. 5, 6, 1909, not *Astralium* (*Lithopoma*) *precursor* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 384, pl. 18, fig. 8, 1892.

Astræa inequalis Martyn, Arnold and Hannibal, Proc. Amer. Phil. Soc., Vol. 52, p. 594, 1913.

Astræa inequale (Martyn), Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 43, 1916.

Astræa (*Pachypoma*) *inæqualis,* variety *pacifica* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 356, August 30, 1919; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 165, pl. 108, figs. 3, 4, 1927.

Pachypoma inæquale Martyn, Dall, U. S. Nat. Mus., Bull. 112, p. 172, 1921.

Astræa (*Pachypoma*) *inæqualis* Martyn, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 164, pl. 108, figs. 1, 2, 1927.

Shell conic, imperforate, rather solid, with a chestnut brown cuticle, lighter beneath; whorls 6-7, planulate above, sutures slightly impressed, bordered below by a series of obliquely descending corrugations, which are cut into granules by from one to five spiral furrows; periphery carinate, subspinose on the upper whorls, usually nearly smooth on body whorl; base nearly flat, concentrically lirate, the liræ more or less tuberculate, five or six in number, their interstices regularly striate; aperture subtriangular, white within, the lower margin fluted; columella arcuate, broad, excavated at position of the umbilicus, and terminating in a tooth-like prominence below. Alt. 45, diam. 55-62 mill. ' (Pilsbry, 1888.)

Miocene: Empire formation of Coos Bay, Oregon (Dall, as *precursor*).

Pliocene: Fernando of Los Angeles, Fourth Street between Hill and Broadway (Moody); upper Pliocene at Bath-house Beach, S. D. S. N. H. loc. 101, Santa Barbara (coll. by U. S. Grant); Santa Barbara (Cooper).

Pliocene-Pleistocene: Coos conglomerate, Coos Bay, Oregon (Dall, 1909, Arnold and Hannibal, 1913).
Pleistocene: Rare in upper San Pedro series of San Pedro (Arnold).
Recent: Vancouver Island, British Columbia, to San Pedro and the Santa Barbara Islands, California (Dall, 1921).

The variety *pacifica* Dall is the typical form of Martyn. The variety *depressa* Dall, 1909, is an individual variant. *Astræa precursor* Dall is not specifically distinct from Martyn's species. The name *precursor* is preoccupied in *Astræa,* but the Empire formation form is probably indistinguishable from Recent variants and hence is not in need of a name.

Genus HOMALOPOMA Carpenter, 1864

Homalopoma Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 537, 588, 627, 1864.
Leptonyx Carpenter, Proc. Calif. Acad. Nat. Sci., Vol. 3, pp. 175, 176, 1864; not *Leptonyx* Swainson, 1833, nor Gray, 1837, nor Lesson, 1842.
Leptothyra Dall, Amer. Journ. Conch., Vol. 7, p. 130, 1871 (as of Carpenter MS.); Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 245, 1888; Dall, Bull. Mus. Comp. Zool., Harvard College, Vol. 18, no. 29, "Blake Gastropoda," p. 351, 1889; Cossmann, Ess. Paléo. Comp., Vol. 11, p. 127, 1918.
Petropoma Gabb, Journ. Acad. Nat. Sci. Phila., Vol. 8, p. 281, 1877, *fide* Pilsbry, Nautilus, Vol. 7, p. 84, 1893.

Type (by monotypy), *Turbo sanguineus* Linnæus, Syst. Nat., Ed. 10, p. 763, 1758; Mediterranean and Adriatic seas; Recent.

Shell small or minute, globose, depressed, solid, compact; umbilicate or imperforate, whorls 3-7, spirally sculptured, the last generally somewhat deflexed at the aperture; aperture subcircular, white and nacreous within; columella generally but not always bluntly denticulate near the base. Operculum subcircular, nearly flat or concavo-convex, inside with a very thin corneous layer, slightly convex, with many gradually increasing whorls, the nucleus subcentral; outside calcareous, subspiral, with a slightly convex concentric elevation or ridge around the margin, most prominent at its termination, the middle portion concave and more or less rugose. (Pilsbry, 1888.)

Homalopoma Carpenter was never described but was used in 1864 with a species, *H. sanguineum,* which was attributed to Linnæus. Although this species was probably not the shell which Carpenter had before him, it is necessary to consider it as the type by monotypy. *Homalopomus* Girard[1] does not preoccupy the name. *Cantrainea* Jeffries and *Anadema* Adams are apparently congeneric.

According to Cossmann, the genus ranges from the Paleocene. The Recent species are in general warm and temperate water inhabitants and are abundant in the Pacific.

Homalopoma carpenteri (Pilsbry)

"*Homalopoma sanguineum* Linnæus," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 537, 588, 627, 1864, not of Linnæus.
"*Leptonyx sanguineus* Linn.," Carpenter, *op. cit.,* p. 627, 1864; Keep, West Coast Shells, p. 87, fig. 73, 1888, 1892; not of Linnæus.
Leptothyra sanguinea Carpenter, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 85, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 245, 1888.
Leptothyra carpenteri Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 247, pl. 39*a*, figs. 26 to 29, pl. 60, fig. 66 (operculum), 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 199, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 323, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2 (p. 42), 1919; Dall, Bull. 112, U. S. Nat. Mus., p. 172, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 167, 1927.

Type specimen: At the Academy of Natural Sciences, Philadelphia.

Type locality: California; Recent.

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[1] Proc. Acad. Nat. Sci. Phila. for 1856, p. 132.

Shell small, globose, very solid, imperforate, spire conic, more or less depressed; suture moderately impressed; whorls 5, slightly convex, the last decidedly deflected toward the aperture, encircled by about fifteen subequal spiral liræ, separated by interstices about as wide as the ridges; growth lines usually strongly developed, causing the liræ to appear nodose or somewhat irregular and the interstices to appear pitted; aperture oblique, pearly-white within, about half the length of the shell; columella arcuate, base obscurely uni- bi- or tri-dentate, color red, ashen, or purple. Alt. 8, diam. 8-9 mill.; dark form, alt. 5, diam. 5 mill. (After Pilsbry, 1888, alt.)

Pliocene: Bath-house Beach, Santa Barbara (Berry).

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro; upper San Pedro series at San Pedro and Crawfish George's (Arnold); Pleistocene chiton bed at Point Firmin, Los Angeles County (E. P. and E. M. Chace); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan); upper Pleistocene one and a half miles west southwest of Goleta, S. D. S. N. H. loc. 74, Santa Barbara County.

Recent: Sitka Sound, Alaska, to San Diego, California (Dall, 1921).

This species increases in size toward the northern limit of its range. Recent specimens from Fort Bragg, northern California, are over 10 mm. in height, while those from San Pedro, Los Angeles County, average 5 or 6 mm. in height. Lower California specimens average about 3 mm. or less. The Goleta Pleistocene specimens measure up to 10 mm. in height.

Leptothyra paucicostata has fewer, more prominent spiral ribs. Both it and *carpenteri* show considerable variation in color, *carpenteri* varying from a light cream color to a ruby red, the common color being a mottled olivaceous brown or gray. Mr. George Willett has collected Recent specimens from off Catalina Island which appear to be intergrades.

This species appears to be the *coccineus* of Troschel, 1879, not of Megerle,[1] 1816, the *californicus* of von Martens, 1878, not of Philippi, 1849, and *purpureus* Carpenter, 1865, not Risso, 1826.

Homalopoma bacula (Carpenter)

Leptonyx bacula Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Proc. Calif. Acad. Nat. Sci., Vol. 3, p. 177, 1864; Keep, West Coast Shells, p. 87, 1888, 1892.

Leptothyra bacula Carpenter, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 85, 1868-9; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 248, pl. 39*a*, fig. 33, 1888; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 245, 1888; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 199, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 323, 1903; U. S. Geol. Surv., Bull. 321, p. 74, pl. 11, fig. 3, 1907; Berry, Nautilus, Vol. 22, p. 38, 1908; Dall, Bull. 112, U. S. Nat. Mus., p. 173, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 167, 1927.

"*Turbo paucicostatus* Dall," Sowerby, Thes. Conch., Vol. 5, *Turbo*, p. 229, pl. 13, fig. 172, 1886, not *Leptothyra paucicostata* Dall, 1871.

Type specimen: California State collection, No. 1,056,—at the University of California ?

Type locality: Catalina Island, California; Recent, coll. by J. G. Cooper.

Pliocene: Santa Barbara formation, upper Pliocene, at Bath-house Beach outcrop, Santa Barbara (Arnold; Berry).

Pleistocene: Lower San Pedro series of Deadman Island, one specimen; also at Los Cerritos (Arnold, 1903).

Recent: Puget Sound to San Martin Island, Lower California (Dall, 1921).

H. bacula can be readily distinguished from *carpenteri* and *paucicostatum* by its much finer spiral sculpture.

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[1] *Turbo coccineus* Megerle, Mag. Ges. Nat. Fr. Berlin, Vol. 8, p. 9, 1816, = *H. sanguineum* (Linnæus), 1758, *fide* Pilsbry, 1888.

Homalopoma paucicostatum (Dall)

Leptothyra paucicostata Dall, Amer. Journ. Conch., Vol. 7, p. 131, pl. 15, fig. 10, 1871; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 10, p. 248, pl. 63, fig. 27, 1888; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 245, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 323, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; Dall, Bull. 112, U. S. Nat. Mus., p. 173, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 168, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Monterey, California; Recent.

Pliocene: Santa Barbara formation, upper Pliocene, at Bath-house Beach, Santa Barbara (Arnold, 1903; Berry).

Pleistocene: Lower San Pedro series of San Pedro, Los Angeles County, "two specimens" (Arnold, 1903).

Recent: Monterey, California, to San Martin Island, Lower California, Mexico (Fred Baker MS.).

Typical *H. paucicostatum* (Dall) is readily distinguished by its few, prominent, spiral ribs. However, a series of specimens obtained by Mr. George Willett from off Catalina Island seems to include specimens intermediate between *paucicostatum* and *carpenteri*, and it is possible that the difference between these two shells is varietal rather than specific.

B. L. Clark has described "*Leptothyra*" *danvillensis*[1] from the San Pablo formation, upper Miocene of middle California. This species resembles *carpenteri* (Pilsbry), but differs, according to Clark, "in that it is larger and the spire is higher; the base is flatter; the concentric ribbing is more regularly interspaced; the interspaces are wider; the sculpturing on the base of the body whorl is finer."

Family TROCHIDAE

Shell nacreous within, conical, pyramidal, subglobose, turbinate or helicoid; aperture entire, tetragonal or rounded; peristome generally not continuous. Operculum circular, thin, entirely corneous, formed of numerous gradually increasing whorls, nucleus central. (Pilsbry, in Tryon's Man. Conch. Ser. 1, Vol. 11, p. 5, 1889.)

This large family differs from the *Turbinidæ* in its thin, horny operculum, the latter family having a heavy calcareous operculum. Both families range back into the Paleozoic, possibly as far as the Ordovician, but the assignment of the more ancient genera to one or the other family is sometimes a matter of conjecture. The larger *Trochidæ* are abundant in warm seas, mostly in shallow water, but some species are encountered at considerable depths. Some of the smaller members of the family, such as *Margarites*, *s. s.*, are boreal in their habitat.

A large number of generic and subgeneric group names have been proposed for this family. Only those which have been used for the Pacific coast Pliocene and Quaternary species, or appear applicable to them, are considered here.

Genus TROCHUS Linnæus, 1758

Trochus Linnæus, Syst. Nat., Ed. 10, p. 756, 1758; Montfort, Conch. Syst., Vol. 2, p. 178, 1810, type cited, "*Trochus niloticus* Linn."; Pilsbry, Man. Conch., Ser. 1, Vol. 11, p. 16, 1889; Cox, Paleontology of Zanzibar Protectorate, p. 83, 1927.

Pyramidea Swainson, Treat. Malac., p. 350, 1840.

Rochia Gray, Guide Moll. Brit. Mus., p. 148, 1857, *fide* Pilsbry, 1889.

Type (by subsequent designation, Thiele, 1924, *fide* Cox), *Trochus maculatus* Linnæus; Recent in Indian Ocean.

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[1] Univ. Calif. Publ. Geol., Vol. 8, no. 22, p. 481, pl. 65, figs. 11, 12, Aug. 30, 1915.

Shell large, thick, solid, the spire pyramidal or conical, periphery angulated or swollen, base flat or slightly convex, with a false umbilicus curving into the aperture; outer and basal lips smooth within, the columella with a strong fold in the umbilical region, ending in an elongate, obtuse tooth or a bluntly denticulated ridge below.

This genus is at present largely distributed in the Old World. No species has been reported in the Neocene or Quaternary of the Pacific coast of North America. The restricted genus probably does not occur earlier than the Tertiary, although formerly Paleozoic and Mesozoic species were assigned to it for want of a better place to put them. Cossmann dates the genus from the Neogene.

It is of interest to note that the type of this genus was not properly designated until 1924, all previous authors having designated *Trochus niloticus* Linnæus, which was not described until the appearance of the 12th edition of the "Systema Naturæ."

Genus NORRISIA Bayle, 1880

Trochiscus Sowerby, Ann. Mag. Nat. Hist., Vol. 2, 1838, p. 96, type, *T. norrisi* Sby.; not *Trochiscus* V. Heyden, 1826, Arachnida; nor *Trochiscus* Held, 1837, Helices.

Norrisia Bayle, Jour. Conchyl. for 1880, p. 241; Fischer, Man. Conchyl., p. 825, 1885.

Type (by monotypy), *Trochiscus norrisi* Sowerby.

Norrisia norrisi (Sowerby)

Trochiscus norrisi Sowerby, Ann. Mag. Nat. Hist., N. S., Vol. 2, p. 96, 1838; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 665, 1864; Dall, Amer. Journ. Conch., Vol. 7, pl. 13, fig. 6, 1871, dentition; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 268, 1888.

Turbo rotelliformis Jay, Cat. Shells, Ed. 3, p. 3, pl. 1, figs. 2, 3, 1859.

Trochiscus convexus Carpenter, Ann. Mag. Nat. Hist., Vol. 15, p. 180, 1865.

Norrisia norrisii Sowerby, Dall in Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 331, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 174, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 172, 1927.

Shell heavy, wide, with low turbinate spire; sculpture lacking except for light growth lines and obscure spiral lines; aperture rounded-quadrangular, pearly within, outer lip simple, thin, columella thickened at base and with a very obtuse tubercle; umbilicus large, open. Large specimens measure 65 mm. in diameter, 45 mm. in axial height.

Pleistocene: Pleistocene (?) at Santa Barbara (Cooper); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro series at Deadman Island, Los Angeles County (Arnold); Pleistocene at Pacific Beach, San Diego (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).

Recent: Monterey, California, to Cedros Island, Lower California.

Genus HALISTYLUS Dall, 1889

Halistylus Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 341, 1889, as subgenus of *Cantharidus* Montfort.

Type (by original designation and monotypy), *H. columna* Dall, *op. cit.*, pl. 9, fig. 7, off Rio Janeiro and Rio Plata, Recent.

"Shell small, cylindrical, holostomate, polychromatic; operculum multispiral, coriaceous; dental formula $\frac{1}{X+4 \,.\, 4+X}$; type: *H. columna* Dall. This group differs from *Leiopyrga* in its holostomate aperture and absence of spiral sculpture." (Dall.)

Halistylus pupoideus (Carpenter)

Fenella pupoidea Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 656, 1864.
Fenella subpupoidea Tryon, Man. Conch., Ser. 1, Vol. 9, p. 394, pl. 60, fig. 77, 1887, new name for *F. pupoidea* Carpenter, 1864, not *F. pupoides* A. Adams, 1860.
Halistylus subpupoideus Tryon, Dall, Bull. 112, U. S. Nat. Mus., p. 174, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 173, 1927.

Whorls about six, convex, closely spirally striate, thin, light olivaceous or brownish, with a series of chestnut spots under the suture; lip simple, sharp. Length, 6 mill. (Tryon.)

Type specimen: In the Academy of Natural Sciences, Philadelphia, *fide* Oldroyd.

Type locality: Monterey, California; Recent.

Pleistocene: Pacific Beach, San Diego (specimens so labeled in Oldroyd Collection at Stanford University).
Recent: Forrester Island, Alaska (Willett), to Panama Bay.

Since *Fenella pupoidea*, described in three words and unfigured by Carpenter, is not a homonym of *Fenella pupoides* A. Adams, a Japanese shell, it is necessary to treat Tryon's name as a synonym, if the International Rules are to be followed.

Genus **TEGULA** Lesson, 1835

Tegula Lesson, Illust. Zoologie, liv. 17, pl. 51, 1835, "*T. elegans*"; Stoliczka, Mem. Geol. Surv. India, Pal. Indica, Cret. Gastrop., p. 364, 1867, type, "*T. pellis-serpentis*"; Pilsbry, Man. Conch., Ser. 1, Vol. 11, p. 163, 1889; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 94, 1909.

Type (by monotypy, *fide* Pilsbry, 1889), *Tegula elegans* Lesson, *op. cit.*, = *Trochus pellis-serpentis* Wood, Index Test. Suppl., pl. 5, fig. 4, 1828, a Recent species ranging from the west coast of Central America to the Gulf of California.

Shell Trochoid or Turbinate, heavy, smaller than *Trochus;* columella twisted and usually terminating below in one or more obtuse projections or denticles; callosity spreading over umbilical region; umbilicus open or closed.

When the genus *Tegula* is subdivided, it is sometimes difficult to place borderline species in the correct division because of the intergradation of closely related groups, although the extreme forms in each group are clearly distinguishable. There are no species of *Tegula, sensu stricto,* in the Pliocene and Quaternary faunas of California.

Subgenus **CHLOROSTOMA** Swainson, 1840

Chlorostoma Swainson, Treat. Malac., p. 350, 1840; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 231, 1846; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 94, 1909.

Type (by subsequent designation, Herrmannsen, 1846), *Trochus argyrostomus* Gmelin, Indo-Pacific, Recent.

This subgenus differs from *Tegula, s. s.*, in the more ventricose whorls, which rapidly increase in size until the penultimate whorl is reached, the body whorl showing a less rapid increase in diameter. This feature of growth gives the penultimate whorl an appearance of disproportionate size and produces a dome-like spire. The sculpture is variable, consisting of spiral ribs, or sometimes of numerous protractive[1] riblets, irregular or granulose. The surface color is often dark purple or dark gray. Beneath the surface the shell is pearly. The aperture is very oblique, the outer lip being smooth and pearly within, the columellar lip bearing one or more obtuse denticles. The umbilicus is open or closed, a callus wash covering the umbilical region.

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[1] That is, sloping to the left or forwards from the upper to the lower suture when the shell is viewed with the spire upwards. Retractive is the opposite, sloping backwards.

Chlorostoma differs from *Calliostoma* in its much heavier shell, dome-shaped spire, less uniform spiral sculpture, teeth or small projections on the columella or basal lip, and the dark or sombre and unattractive outer shell layer. *Calliostoma, s. s.*, has an imperforate axis.

This group of shells is characteristic of the Indo-Pacific and of both the eastern and western sides of the Pacific. It does not appear to be represented in the Atlantic.

Section CHLOROSTOMA, s. s.

With axial or spiral riblets or both, outer shell layer usually dark purple or black.

Omphalius differs in its much reduced or entirely obsolete sculpture and its rather smooth, light-colored outer shell layer. The retention here of *Omphalius* as a subdivision distinct from *Chlorostoma* is based upon the presence or absence of the spiral or the oblique axial sculpture and dark outer shell layer characteristic of species of typical *Chlorostoma*. The dividing line is not sharp and some species may fit as well in either section.

Tegula (Chlorostoma) funebralis (A. Adams)

Plate 32, Figures 28*a*, 28*b*, 29

Chlorostoma funebrale A. Adams, Proc. Zool. Soc. London for 1854, p. 316; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 84, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 234, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 170, pl. 28, figs. 42-44, 1889; Keep, West Coast Shells, p. 84, fig. 71, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, pl. 21, fig. 7, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 325, 1903.

Trochus moestus Jonas, variety, Gould, U. S. Expl. Exped., Vol. 12, Mollusca, p. 183, 1852, Atlas, pl. 13, fig. 214, 1856.

Trochus funebralis A. Adams, Fischer, Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 173, pl. 57, fig. 3, 1880.

Tegula funebrale A. Adams, E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2 (p. 42), 1919.

Tegula (Chlorostoma) funebrale A. Adams, Dall, U. S. Nat. Mus., Bull. 112, p. 174, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 173, pl. 98, figs. 8, 9, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Type specimen: In the Museum Cuming, collection now in the British Museum.

Type locality: California, Recent.

Pliocene: S. D. S. N. H. loc. 221, Cañada de Aliso, loc. 222, Cañada de las Encinas, middle or upper Pico of Ventura County (H. R. G.); loc. 225, between Santa Paula Creek and Timber Canyon, upper Pliocene, Ventura County (H. R. G.); upper and "lower" (= middle) Pico near Ventura (Waterfall).

Pleistocene: Rare in lower San Pedro series at Deadman Island and San Pedro (Arnold); Saugus near Ventura (Waterfall); upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, Long Beach, and Crawfish George's (Arnold); fossil chiton bed, Pt. Firmin, Los Angeles County (E. P. and E. M. Chace); Pleistocene of Barlow's Ranch, Ventura, and at Pacific Beach, San Diego (Arnold).

Recent: Vancouver Island, British Columbia, to Cedros Island, Lower California, Mexico (Dall, 1921); subfossil in kitchen middens at Pismo Beach, also twelve miles west of Paso Robles, etc.

This species is somewhat variable in sculptural development. "It is lustreless, purple or black, the apex usually eroded, orange-colored; the teeth of the columella are white; and there is never a yellowish streak at the base, as in the var. *tincta* [of *T. gallina* (Forbes)]. The whorls are spirally lirate, sometimes smooth except on the base, sometimes strongly lirate above. The suture is margined below by an impressed line, and by elevated, foliaceous incremental lamellæ. This last feature may almost always be detected, although sometimes but very slightly developed. Alt. 35, diam. 32; alt. 25, diam. 26 mill." (Pilsbry.)

This species was formerly used as food by the Indians of California. The shells occur in abundance in a kitchen midden north of Pismo Beach, and they are not uncommon at an ancient Indian camp twelve miles west of Paso Robles, at an elevation of about 1200 feet and ten or more miles from the coast. At the latter deposit, which was first reported to be of Pleistocene age, many of the shells lack the upper portion of the spire or only the top of the spire remains, the Indians probably having broken the shells in this manner to extract the animal. Arrow heads occur with the shells at the latter locality.

T. funebralis is distinguished from *T. gallina* by the lack of the axial riblets or stripes so common on the latter species. The puckered, finely pleated, or foliated growth lines just below the suture provide another distinguishing character.

Tegula (Chlorostoma) funebralis (A. Adams) variety **subaperta** (Carpenter)

Chlorostoma funebrale var. *subapertum* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Dall, Proc. U. S. Nat. Mus., Vol. 15, p. 200, pl. 21, fig. 6, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 325, 1903.

Tegula (*Chlorostoma*) *funebrale subapertum* Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 174, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 174, 1927.

"With umbilical pit." (Carpenter.)

Pleistocene: San Pedro (Arnold).
Recent: Neah Bay, Washington, to San Diego (Fred Baker).

This variety is of very doubtful value.

Tegula (Chlorostoma) dubiosa, new name

Astralium arnoldi Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 204, pl. 10, figs. 2*a*, 2*b*, 1916; not *Tegula arnoldi* Weaver, Washington Geol. Surv., Bull. 15, p. 71, pl. 6, fig. 62, 1912.

Type specimen: In the University of California collection.

Type locality: SE ¼, Sec. 27, T. 21 S, R. 14 E, Mount Diablo Base and Meridian, near Coalinga; lower Pliocene.

Pliocene: At the type locality.

This species is probably more closely related to *Tegula funebralis* (A. Adams) than to any other, but the spiral sculpture on *dubiosa* is so much coarser and more prominent that it may be specifically distinct. Unfortunately the specific name *arnoldi* was preoccupied in *Tegula*, which makes a new name imperative.

Tegula (Chlorostoma) gallina (Forbes)

Plate 32, Figures 30, 31

Trochus (*Monodonta*) *gallina* Forbes, Proc. Zool. Soc. London, p. 271, pl. 11, figs. 8*a*-*b*, 1850.

Trochus gallina Forbes, Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 538, pl. 111, fig. 1, 1880.

Trochus (*Monodonta*) *pyriformis* Gould, Boston Journ. Nat. Hist., Vol. 6, p. 382, 1853.

Chlorostoma gallina Forbes, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 169, pl. 20, fig. 5, pl. 28, figs. 52, 53, 1889; Keep, West Coast Shells, p. 84, fig. 70, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 326, 1903.

Tegula (*Chlorostoma*) *gallina* Forbes, Dall, U. S. Nat. Mus., Bull. 112, p. 174, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 174, 1927.

Tegula gallina Forbes, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, no. 7, p. 247, 1926.

Type specimen: Presumably in the British Museum.

Type localities: Of *gallina*, "probably from the Mazatlan coast" (Forbes); of *pyriformis*, San Diego, California.

Pliocene: S. D. S. N. H. loc. 207, basal Pico Pliocene of Elsmere Canyon; loc. 216, basal Pico east of Fernando Pass; loc. 214, middle Pico of Fernando Pass, Los Angeles County, all uncommon (H. R. G.).
Pleistocene: "Rare in the upper San Pedro series of San Pedro, Crawfish George's, and Deadman Island," Los Angeles County; Pleistocene at Pacific Beach, San Diego County (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Francisco, California, to the Gulf of California, Mexico.

This large, heavy-shelled species is characterized by the oblique axial riblets, which consist of closely spaced, sometimes irregular, superficial folds on the surface of the shell. The interspaces between these riblets are often lighter colored, giving a striped effect. However, this sculpture varies from strong to nearly obsolete and the riblets are sometimes granulose.

The variety with an open umbilicus Dall has named *umbilicata*.[1] The presence or absence of an umbilicus in *Tegula* is frequently a function of the amount of callus deposited in the umbilical region, the umbilicus being structurally present even in the imperforate individuals, although covered over basally by the deposit of shelly substance. The Recent range of the variation *umbilicata* is coincident with that of the typical form, which helps to confirm the opinion that *umbilicata* is no more than an individual variation. Until more data on the actual occurrence of living specimens is available, we consider the "variety" a cabinet name.

The variety with obsolete sculpture and a yellowish streak on the base just below the columellar teeth is known as variety *tincta* Hemphill in Pilsbry, 1889. Still another variety, characterized by strong spiral sculpture, has been named *multifilosa* by Stearns.[2] The geographic range of this form falls within that of the typical form.

Tegula (? Chlorostoma) lahondaensis (Arnold)

Chlorostoma stantoni Dall, var. *lahondaensis* Arnold, Proc. U. S. Nat. Mus., Vol. 34, p. 388, pl. 36, fig. 2, August, 1908.

Broad, low spired, with few rounded ribs; attaining an altitude of 25 mm.

Type specimen: "L. S. J. U., No. 1,079."

Type locality: Along Pescadero Creek, three miles south of La Honda, San Mateo County; Pliocene (Arnold).

Pliocene: Lower Pliocene (lower Purisima formation) on Pescadero Creek, just above mouth of Jones Gulch, three miles due south of La Honda, San Mateo County, California (Arnold).

Since Arnold described variety *lahondaensis* before Dall proposed in print the name *stantoni*, Arnold's form will have to be considered the typical form, *lahondaensis*, and Dall's Coos Bay form the variety or subspecies. Neither form is a typical *Chlorostoma*.

Tegula (? Chlorostoma) lahondaensis (Arnold) variety **stantoni** Dall

Tegula (*Chlorostoma*) *stantoni* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 95, pl. 2, figs. 10, 11, April, 1909.

Type specimen: In the U. S. National Museum, No. 107,777.

Type locality: "Miocene of Coos Bay, Oregon" (Dall).

Miocene: At the type locality, upper Miocene.
Pliocene: "Lower Purisima formation, Santa Cruz County, California, Arnold" (Dall).

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[1] Proc. U. S. Nat. Mus., Vol. 56, p. 359, 1919, type locality, San Quintin Bay, Lower California.

[2] Proc. U. S. Nat. Mus., Vol. 16, p. 351, pl. 50, figs. 8, 9, 1893.

Dall figures a rather low-spired shell, with few, widely spaced, prominent ribs. The apertural characters are obscured by matrix. This shell is more elevated and has more prominent spiral sculpture than *lahondaensis*. It is far from being a typical *Chlorostoma* and may not be a *Tegula*.

Tegula (? Chlorostoma) ligulata (Menke)

Trochus ligulatus Menke, Zeitschr. f. Malak., for 1850, p. 173; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 382, pl. 115, fig. 5, 1880.

Omphalius ligulatus Menke, Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 235, 1857.

Trochus luridus Nuttall, MS., Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 233, 1857.

"*Omphalius fuscescens* Philippi," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864, not of Philippi, Abbild. Beschreib., Vol. 1, *Trochus*, pl. 3, fig. 8, 1844; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 255, 1888; Keep, West Coast Shells, p. 82, fig. 68, 1888, 1892.

Chlorostoma (*Omphalius*) *viridulum* Gmelin, var. *ligulatum* Menke, Pilsbry, Tryon's Man. Conch. Ser. 1, Vol. 11, p. 177, pl. 29, figs. 58-60, 1889; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, 1892.

Omphalius ligulatus Menke, Dall, Bull. 112, U. S. Nat. Mus., p. 175, 1921.

Tegula ligulata Menke, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 247, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 181, 1927.

Type locality: Mazatlan, Mexico, *fide* Oldroyd.

Pleistocene: "Rare in lower San Pedro series of Deadman Island and San Pedro, Los Angeles County (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro series of Los Cerritos and Crawfish George's, common (Arnold); rare in upper San Pedro of Deadman Island and San Pedro, Los Angeles County (Arnold); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to Acapulco, Mexico (Dall).

This species is extremely variable. The shell is usually turbinate, the whorls quite ventricose and sculptured with spiral riblets, which are in most cases granulose. The umbilicus is wide open and the columellar lip has two or three small denticles. The basal lip bears a few liræ which extend back into the aperture. The whorls and aperture are smaller than in *T. viridula* (Gmelin), and the columella lacks the green tinge. This species also lacks the broad radiating stripes of *T. reticulata* (Wood) and *T. viridula*.

Section Omphalius Philippi, 1847

Omphalius Philippi, Zeitschrift f. Malak., for 1847, p. 21; Herrmannsen, Indicis Gen. Malac., Vol. 2, p. 146, Sept. 8, 1847.

Type (by subsequent designation, Herrmannsen, 1847), *Trochus rusticus* Gmelin, Japan; Recent.

The intermingling of the characters that might be used for sectional differentiation among the species of *Chlorostoma* makes it difficult to define *Omphalius* in a manner that will not be obviously artificial. The name could be discarded without any loss to systematics, but it is utilized here for a few species that are like the type or lack some of the more obvious characters of *Chlorostoma, s. s.* For example, *Tegula brunnea* (Philippi), of California, is similar to *T. rustica* (Gmelin), of Japan, at least to the variety of the latter which has a smooth, light yellowish-brown outer shell surface. The spiral sculpture and (in *brunnea* and the smooth *rustica*) the oblique axial riblets are wanting. The presence or absence of an open umbilicus is entirely unreliable for systematic arrangement in the group of which *rustica* is an example. The widely open, funnel-shaped umbilicus of species such as *T. montereyi*, however, seems to be significant, but it has a very different appearance when coupled with a flat base and angulated body whorl.

Tegula (Chlorostoma) brunnea (Philippi)

Trochus brunneus Philippi, Zeitschr. f. Malak., for 1848, p. 189; ? Lischke, Japan. Meeres-Conchyl., Vol. 1, p. 99, 1869; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 365, pl. 112, fig. 1, 1880.

Chlorostoma brunneum Philippi, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 84, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 234, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 170, pl. 27, figs. 36-38, 1889; Keep, West Coast Shells, p. 83, fig. 69, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, pl. 21, fig. 8, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 324, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 174, 1921.

Tegula brunnea Philippi, E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2 (p. 42), 1919.

Tegula (Chlorostoma) brunnea Philippi, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 176, 1927.

Shell imperforate, conical, solid; color russet-yellow, brown, orange, or deep crimson; spire conic; sutures deeply impressed; whorls about seven, convex, smooth, with light, oblique striæ, the last whorl sometimes indistinctly undulated or plicate below the suture; base depressed, deeply concave in the center; aperture very oblique; columella one or two toothed near the base; umbilical callus white; place of the umbilicus deeply excavated. Alt. 32, diam. 36; alt. 38, diam. 35 mill. (After Pilsbry, alt.)

Pleistocene: "Pliocene" of Deadman Island, rare; upper San Pedro series of Deadman Island and Crawfish George's, Los Angeles County (Arnold); Pleistocene at the chiton bed, Pt. Firmin, Los Angeles County (E. P. and E. M. Chace).

Recent: Mendocino County to the Santa Barbara Islands, California (Dall).

This species is very close to *T. rustica* (Gmelin) of Japan, the type of *Omphalius.* Lischke reported it on the coast of Japan, but the form he reported may have been *rustica.* It certainly belongs to *Omphalius,* if that section is of any value.

Tegula (Chlorostoma) aureotincta (Forbes)

Trochus (Monodonta) aureo-tinctus Forbes, Proc. Zool. Soc. London for 1850, p. 271, pl. 11, fig. 7.

Chlorostoma aureotinctum Forbes, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, pp. 652, 667, 1864; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 234, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 172, pl. 27, figs. 31-33, 1889; Keep, West Coast Shells, p. 84, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 324, 1903.

Trochus aureo-tinctus Forbes, Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 11, p. 94, pl. 31, fig. 1, 1873.

Omphalius aureotinctus Forbes, Dall, Bull. 112, U. S. Nat. Mus., p. 175, 1921.

Tegula aureotincta Forbes, E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Tegula (Omphalius) aureotincta Forbes, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 180, 1927.

Pleistocene: Santa Barbara (Cooper); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro series at San Pedro, rare (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Santa Barbara Islands, California, to Magdalena Bay, Lower California, Mexico (Dall).

This species is characterized by its turbinate shape, its few, low, rounded spiral ribs on the base, its undulated and nodose whorls, and its open umbilicus tinted with orange. It is beautifully figured in color by Forbes.

Tegula (Chlorostoma) hemphilli T. S. Oldroyd

Tegula hemphilli T. S. Oldroyd, Nautilus, Vol. 34, no. 4, p. 115, pl. 5, figs. 11, 11*a*, April, 1921.

Type specimen: At the University of California.

Type locality: Pacific Beach, San Diego; Pleistocene.

Pleistocene: Pacific Beach, San Diego (Oldroyd).

This shell has low undulations or nodosities and fine spiral threads, which are somewhat granulose. It is a rather depressed form, with the base flatly convex and a wide, open umbilicus. There are two small denticles on the columellar lip.

Tegula (? Chlorostoma) pulcella Nomland

Tegula (*Chlorostoma*) *pulcella* Nomland, Univ. Calif. Publ. Geol., Vol. 10, no. 14, p. 235, pl. 12, figs. 3, 3*a*, 1917.

Type specimen: At the University of California, type no. 11,101.

Type locality: Coalinga district, California; upper middle Pliocene.

Pliocene: "*Pecten coalingensis* zone," upper Etchegoin of the Coalinga region, California.

This species is characterized by its conical, flat-sided shape, with a flat base, open umbilicus, and low, rounded axial riblets. It is certainly far from typical *Chlorostoma* or *Omphalius* and may belong in another group. Its shape suggests possible relationship with *T. montereyi* (Fischer in Kiener). It can hardly belong to *Promartynia* Dall.[1]

INCERTAE SEDIS

Tegula montereyi (Fischer in Kiener)

"*Omphalius pfeifferi* Philippi," Carpenter, Proc. Zool. Soc. London, for 1856, p. 204, 1856, not *Trochus pfeifferi* Philippi, Zeitschr. f. Malak., for 1846, p. 104.

"*Chlorostoma pfeifferi* Philippi," Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 84, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 234, 1888; Keep, West Coast Shells, p. 83, 1888, 1892.

Trochus montereyi Fischer in Kiener, Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 104, pl. 33, figs. 1, 1*a*, 1880.

Chlorostoma montereyensis Kiener, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 200, 1892.

Chlorostoma montereyi Kiener, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 326, pl. 10, fig. 19, 1903.

Shell evenly conical, of five or six flat-sided whorls; base of body whorl flat; umbilicus open, funnel-like, with a bordering spiral rib; sculpture much reduced, consisting essentially of fine spiral threadlets crossed by faint growth lines. Measurements of average mature specimen, diameter at base 35 mm., slant height 35 mm.

Type locality: California coast; Monterey (Fischer in Kiener).

Pleistocene: "Pliocene of Deadman Island"; lower San Pedro series of Deadman Island; upper San Pedro series of Deadman Island, Crawfish George's, and San Pedro, Los Angeles County; Pleistocene of Pacific Beach, San Diego County (Arnold).

Recent: Baulinas Bay, middle California, to the Santa Barbara Islands (Dall).

This species is very different from the other California shells assigned to *Chlorostoma* or *Omphalius*. It appears to belong in a different subgenus. *Phorcus* Risso[2] seems to have a differently shaped body whorl.

Several species of *Tegula*, *s. l.*, occur in the earlier Tertiary of the Pacific coast. Among them are *Tegula danvillensis* Clark and *T. nashi* Clark from the San Pablo formation of middle California, *T. thea* Nomland and *T. varistriata* Nomland from the Santa Margarita upper Miocene at several localities, and *T. arnoldi* Weaver from the Blakeley formation, lower Miocene of Washington.

Genus **CALLIOSTOMA** Swainson, 1840

Calliostoma Swainson, Treat. Malac., pp. 218, 351, 1840; list includes "*C. conula* Mart."; Herrmannsen, Indicis Gen. Malac., Vol. 1, p. 154, 1846; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 332, 1889; Cossmann, Ess. Paléo. Comp., Vol. 11, p. 288, 1918.

Ziziphinus Gray, Syn. Cont. Brit. Mus., 1840, type *T. zizyphinus* Linnæus.

Type (by subsequent designation, Herrmannsen, 1846), *Trochus conulus* Linnæus (= "*Calliostoma conula* Mart." of Swainson), Mediterranean Sea; Recent.

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[1] U. S. Geol. Survey, Prof. Paper 59, p. 94, 1909, type by original designation, *P. pulligo* (Martyn).

[2] Hist. Nat. Eur. Mérid., Vol. 4, p. 133, 1826; type, *Trochus richardi* Payraudeau, = *Phorcus margaritaceus* Risso, *fide* Bucquoy, Dautzenberg, and Dollfus, Moll. Mar. Roussillon, Vol. 2, fasc. 10, p. 399, 1885.

Imperforate; spire elevated, acute; aperture broader than high, transversely ovate, hardly sinuated at the base, and slightly oblique; shells always smooth, and often polished. (Swainson.)

Geologic range: Eocene to Recent (Cossmann).

Distribution: All seas.

Dall[1] has suggested that *Leiotrochus* Conrad may be used for the umbilicated Calliostomas.

Calliostoma annulatum (Martyn)

Trochus annulatus Martyn, Univ. Conch., table 1, pl. 33, 1784; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 74, pl. 16, fig. 3, 1880.

Trochus virgineus Chemnitz, Neues Syst. Conch. Cab., Vol. 10, p. 289, pl. 165, figs. 1581-2, 1788.

Zizyphinus annulatus Martyn, A. Adams, Proc. Zool. Soc. London for 1851, p. 164.

Calliostoma annulatum Martyn, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 83, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 231, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 363, pl. 67, fig. 43, 1889; Keep, West Coast Shells, p. 79, fig. 64, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, pl. 22, fig. 2, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 329, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 176, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 184, pl. 97, figs. 1, 3, 1927.

Calliostoma annulatum Martyn, n. var. ? Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: San Diego well, southwest corner of Balboa Park, San Diego, California (Dall); Pico near Ventura, as new variety (Waterfall).

Pleistocene: S. D. S. N. H. loc. 233, "Saugus" formation north of Arroyo Santa Rosa, Ventura County, fragments (Grant, coll.); quite rare in upper San Pedro series of San Pedro (Arnold); Pleistocene, San Pedro to San Diego (Cooper).

Recent: Forrester Island, Alaska, to Catalina Island, California (Dall).

This very handsome species has granular spiral riblets and a delicate lavender color band just above and adjacent to the lower suture of each whorl. The basal periphery of the body whorl is angular. Large specimens have a diameter of 25 mm. and a slant-height of nearly 30 mm.

C. variegatum Carpenter has a somewhat inflated body whorl, without the angle at the base, and the coloration is less brilliant.

Calliostoma kerri Arnold

Calliostoma kerri Arnold, U. S. Geol. Surv., Bull. 396, p. 84, pl. 27, fig. 6, January 15, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, no. 14, p. 220, 1917.

Type specimen: In the U. S. National Museum, No. 165,500.

Type locality: Immediately east of Henry Spring, four miles south of Coalinga, California; Etchegoin Pliocene.

Pliocene: Etchegoin of south central part of Kettleman Hills; east of Zapato Creek; four miles south of Coalinga, all Coalinga district, west side of San Joaquin basin (Arnold); *Pecten coalingensis* zone, "common," Coalinga district (Nomland).

Arnold distinguished this species from the Recent *Calliostoma variegatum* Carpenter[2] "by its relatively broader outline, more nearly flat base, less prominently nodose revolving sculpture, and smaller and smoother concentric ribs on the base; also by the greater inequality between the outer and inner basal ribs on the one hand and the intermediate ones on the other."

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[1] U. S. Geol. Surv., Prof. Paper 59, p. 95, 1909.

[2] Proc. Acad. Nat. Sci. Phila. for 1865, p. 61; see Proc. U. S. Nat. Mus., Vol. 24, p. 552, pl. 39, fig. 10, 1902; range Puget Sound to Cedros Island, Lower California.

Calliostoma canaliculatum (Martyn)

Plate 32, Figure 23

Trochus canaliculatus Martyn, Univ. Conch., table 1, pl. 32, 1784.

Trochus doliarius Chemnitz, Neues Syst. Conch. Cab., Vol. 10, p. 288, pl. 165, figs. 1579, 1580, 1788; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 71, pl. 16, fig. 1, 1880.

Calliostoma canaliculatum Martyn, Cooper, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 83, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 231, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 361, pl. 67, fig. 49, Vol. 10, pl. 41, fig. 34, 1889; Keep, West Coast Shells, p. 80, fig. 65, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, pl. 22, fig. 6, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 329, 1903; Berry, Nautilus, Vol. 22, p. 38, 1908; Dall, Bull. 112, U. S. Nat. Mus., p. 176, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 247, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 184, pl. 97, figs. 4, 6, 1927.

Pliocene: Pacific Beach, San Diego (Arnold); Bath-house Beach outcrop, Santa Barbara formation, upper Pliocene, Santa Barbara (Berry).

Pleistocene: "Pliocene" of Deadman Island, rare, and rare in lower San Pedro series of Deadman Island and San Pedro; common in upper San Pedro series of Deadman Island, San Pedro, Los Cerritos, and Crawfish George's, all Los Angeles County (Arnold); Pleistocene at Spanish Bight (Arnold; Mrs. K. Stephens MS.); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Sitka, Alaska, to San Diego, California (Dall).

This species is readily distinguished by its large size, prominent spiral riblets, and flattened base. The ribs are very evenly spaced, those on the earlier whorls being few in number, but they are augmented toward the body whorl by the gradually increasing prominence of the intercalated riblets. The base of the body whorl is angulated. Full-grown individuals attain a diameter of 25 mm. and an axial height of 25 mm.

C. costatum (Martyn) has a much stronger shell, a rounded body whorl, and is smaller.

The variety *nebulosum* Dall takes the place of *parvum* Williamson, the latter name being preoccupied by Da Costa. It is probably of no consequence and should be synonymized along with the supposed variety *transliratum* Dall.

Calliostoma costatum (Martyn)

Plate 32, Figure 25

Trochus costatus Martyn, Univ. Conch., table 1, pl. 34, 1784, not *Trochus costatus* Gmelin, 1788.

Trochus filosus Wood, Index Test., Suppl., pl. 5, fig. 23, 1828; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 199, pl. 64, figs. 5, 1880.

? *Trochus modestus* Middendorff, Beitr. Mal. Rossica, Vol. 2, p. 85, pl. 10, figs. 16-18, 1847.

Trochus ligatus Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 91, March, 1849; U. S. Expl. Exped., Vol. 12, Mollusca, p. 185, 1852, Atlas, pl. 12, figs. 207*a-b*, 1856.

Trochus castaneus Nuttall MS., Forbes, Proc. Zool. Soc. London for 1850, p. 271, pl. 11, fig. 9.

Calliostoma costatum Martyn, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 652, 1864; Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 83, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 231, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 362, 1889; Keep, West Coast Shells, p. 81, fig. 66, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 201, pl. 22, fig. 1, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 330, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 175, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 183, pl. 97, figs. 8, 10, 1927.

Calliostoma etchegoinensis Nomland, Univ. Calif. Publ. Geol., Vol. 9, no. 6, p. 85, pl. 7, fig. 3, 1916.

Calliostoma costatum variety *cæruleum* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 359, 1919.

Calliostoma costatum variety *pictum* Dall, *op. cit.*, p. 359, 1919.

Calliostoma costatum cæruleum Dall, U. S. Nat. Mus., Bull. 112, p. 175, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 183, 1927.

Calliostoma costatum pictum Dall, U. S. Nat. Mus., Bull. 112, p. 176, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, 1927.

Smaller, heavier shelled, with less prominent spiral sculpture and more rounded body whorl than *C. canaliculatum*.

Type locality: "King Georges Sound." (Martyn.)

Pliocene: Etchegoin formation north of Oilfields, Coalinga region, California (Nomland); San Fernando, Los Angeles County (Cooper).
Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, rare; upper San Pedro series of Crawfish George's, Los Cerritos, and San Pedro; Pleistocene at Pacific Beach, San Diego (Arnold).
Recent: Sitka, Alaska, to San Diego, California (Dall).

This species is similar to a large *Margarites.* Nomland's *etchegoinense* is the young of Martyn's species, the angulated body whorl being a juvenile character. Recent specimens have slightly granulose ribs, the granulations becoming emphasized through weathering.

Shells with the apex and part of the whorls in front of the suture colored with bands of mazarin blue when fresh were named variety *cœruleum* by Dall, and those with alternating light and dark patches or clouds of color were named variety *pictum* by the same author. Both names apply to individual variants and are entirely unnecessary.

Calliostoma augustinense Hertlein

Calliostoma augustinensis Hertlein, Journ. Paleo., Vol. 2, p. 154, pl. 25, figs. 4, 5, June, 1928.

Shell rather low, conic, imperforate, fairly thin; about 4 rounded whorls present; body whorl broadly rounded below; surface with numerous, fine, even, spiral, rather flat-topped ribs, which are separated by smaller fine lines. Height, 21 mm.; length, 29 mm.

Type specimen: No. 4,146, California Academy of Sciences.

Type locality: San Augustine Canyon, Santa Rosa Island, California; lower Miocene.

Miocene: Vaqueros formation at the type locality.

Calliostoma coalingense Arnold

Calliostoma coalingensis Arnold, U. S. Geol. Surv., Bull. 396, p. 83, pl. 27, fig. 7, January 15, 1910; Bull. 398, pl. 49, fig. 7, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, table opp. p. 230, 1910.

Type specimen: In the U. S. National Museum, No. 165,499.

Type locality: Coalinga district, California; Pliocene.

Pliocene: Pecten coalingensis horizon near top of Etchegoin formation, near Zapato Creek; also four miles south of Coalinga, west side San Joaquin basin (Arnold); Etchegoin of Coalinga, common in "*Chione elsmerensis,*" "*Turritella nova*" and "*Pecten coalingensis*" zones (Nomland).

Arnold differentiated this species from *Calliostoma costatum* (Martyn) by "its relatively lower spire, more convex and angulated whorls, narrower, more numerous, more markedly unequal, and often slightly nodose revolving ribs." This form should, perhaps, be considered a variety of *costatum.*

Calliostoma cammani Dall

Calliostoma cammani Dall, U. S. Geol. Surv., Prof. Paper 59, pp. 18, 96, pl. 2, figs. 8, 9, April, 1909; Arnold and Hannibal, Proc. Amer. Philos. Soc., Vol. 52, p. 590, 1913.

Type specimen: In the U. S. National Museum, No. 107,776.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Coos Bay, Oregon (Dall); "shaly sandstone, beach between submerged jetty and Fossil Rock, three miles south of Empire, Coos Bay, Oregon" (Arnold and Hannibal); upper Miocene.

Dall states: "This strongly spirally sculptured species recalls the more acute and elevated *C. virginicum* of Conrad, from the Virginia Miocene. In its sculpture it resembles *Chlorostoma stantoni* Dall, of the Empire formation of Coos Bay, but can readily be discriminated."

Calliostoma gemmulatum Carpenter

Plate 32, Figure 21

Calliostoma gemmulatum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 653, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 215, 1864; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 231, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 371, pl. 67, fig. 54, 1889; Keep, West Coast Shells, p. 81, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 201, pl. 22, fig. 3, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 330, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 176, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 189, 1927.

Type specimen: In the U. S. National Museum.

Type locality: California.

Pliocene: Packard's Hill, Santa Barbara (Arnold).
Pleistocene: Upper San Pedro series of San Pedro, Los Cerritos, and Crawfish George's, Los Angeles County; Pleistocene at Spanish Bight (Arnold); Pleistocene terrace a half mile south of Sea Cliff on Southern Pacific R. R., eight miles north of Ventura (coll. by Farish and Smith).
Recent: San Pedro, California, to Gulf of California.

This species is a rather high-spired form, with a few prominent, granular spiral ribs, two on the early whorls, but the number increasing to four or five on the body whorl by the increase in prominence of intercalated riblets. The upper part of each whorl is slopingly, somewhat concavely tabulated. Average mature individuals measure 24 mm. in axial length and 20 mm. in diameter at the base.

This species is heavier shelled, with fewer, more prominent spiral ribs than *Calliostoma annulatum* (Martyn).

Calliostoma eximium (Reeve)

Trochus eximius Reeve, Proc. Zool. Soc. London for 1842, p. 185; Conch. Syst., Vol. 2, p. 165, pl. 208, fig. 12, 1842; Fischer, in Kiener's Spéc. Gén. Icon. Coq. Viv., Vol. 12, p. 196, pl. 64, fig. 1, 1880.
Trochus versicolor Menke, Zeitschr. f. Malak., p. 172, 1850; Carpenter, Cat. Reigen. Coll. Mazatlan Moll. Brit. Mus., p. 231, 1857.
? *Zizyphinus californicus* A. Adams, Proc. Zool. Soc. London for 1851, p. 168.
Zizyphinus eximius Reeve, Conch. Icon., Vol. 14, sp. 25, pl. 4, figs. 25*a-b*, 1863.
Calliostoma eximium Reeve, Pilsbry, Tryon's Man. Conch., Vol. 11, p. 366, pl. 65, figs. 84-86, 1889; also figured in Vol. 10, pl. 41, fig. 28; Dall, U. S. Nat. Mus., Bull. 112, p. 176, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 188, 1927.

Type locality: Panama; Recent.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan).
Recent: Santa Catalina Island, California, to Mazatlan, Mexico (Dall).

This species is readily recognizable by the carinated whorls, which are concave above and straight and approximately vertical below. There are very low spiral cords on the base of the body whorl and inconspicuous spiral threads on the upper portion of the shell.

Calliostoma hannibali Hertlein and Jordan

Calliostoma hannibali Hertlein and Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 626, pl. 21, figs. 8, 9, Sept. 2, 1927.

Shell small, rather thin, conical, imperforate; tip of spire missing, four and one-half whorls present in type specimen; whorls sloping and broadly rounded to near periphery where a small angular shoulder is present; from shoulder, whorls slope abruptly to base; body whorl rounded at periphery; near base whorls ornamented by a raised spiral line; on next to last whorl a raised spiral line occurs midway between suture and angular shoulder; whorls ornamented by numerous fine spiral lines which are strongest on base of body whorl. Height approximately 20.5 mm.; width of body whorl 12.5 mm.; apical angle approximately 83°. (Hertlein and Jordan.)

Type specimen: In the Stanford University collection.

Type locality: In Arroyo San Ignacio, southwest of San Ignacio, Lower California, Mexico, Isidro formation; lower Miocene.

Miocene: At the type locality.

The type of this species is not very edifying but it might be related to *C. eximium* (Reeve).

Calliostoma tricolor Gabb

Calliostoma tricolor Gabb, Proc. Calif. Acad. Nat. Sci., Vol. 3, p. 186, 1865; Geol. Surv. Calif., Palæo., Vol. 2, p. 17, 1866, pl. 3, fig. 28, 1868-9; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 231, 1888; Pilsbry, Tryon's Man. Conch., Vol. 11, p. 370, pl. 67, fig. 52, 1889; Keep, West Coast Shells, p. 82, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, pl. 19, fig. 8, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 331, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 176, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 247, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 188, 1927.

Like *C. eximium* (Reeve), but not concave above the middle of the whorls, and the carina not so pronounced.

Type specimen: Location not known, *fide* Stewart, Proc. Acad. Nat. Sci. Phila., Vol. 78, p. 291, 1927.

Type locality: San Pedro, California.

Pleistocene: "Pliocene" of Deadman Island, rare; lower San Pedro series at San Pedro (Arnold); lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan, 1924); upper San Pedro series of Crawfish George's, San Pedro, and Los Cerritos, Los Angeles County; Pleistocene at Spanish Bight (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).
Recent: Santa Cruz to San Diego, California (Dall).

This species is very closely related to *C. eximium.* Some specimens have a slight depression in the umbilical region.

Calliostoma gloriosum Dall

Calliostoma gloriosum Dall, Amer. Journ. Conch., Vol. 7, p. 127, Nov. 2, 1871; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 368, pl. 67, fig. 70, 1889; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 201, pl. 22, fig. 5, 1892; Dall, U. S. Nat. Mus., Bull. 112, p. 176, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924; Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 247, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 187, 1927.

Type specimen: In the U. S. National Museum.

Type locality: Soquel, north side of Monterey Bay, California.

Pleistocene: In the lower Quaternary at Magdalena Bay (Jordan, 1924) and in the upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan, 1926).
Recent: "Twelve miles south of the Golden Gate and thence to San Diego, California" (Dall, 1921).

This species is somewhat like *C. tricolor* Gabb but lacks the carina, and the fine spiral threads are a little more conspicuous and granulose.

Calliostoma supragranosum Carpenter

Calliostoma formosum Carpenter, Proc. Calif. Acad. Sci., Vol. 3, p. 156, 1865, not *T. formosus* Forbes, 1847.
Calliostoma supragranosum Carpenter, *op. cit.*, p. 214, 1865; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 369, pl. 67, fig. 71, 1889; E. P. and E. M. Chace, Lorquinia, Vol. 2, No. 6, p. 2 (p. 42), 1919; Dall, Bull. 112, U. S. Nat. Mus., p. 176, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 189, 1927.

Type locality: San Pedro, California; Recent.

Pleistocene: Pleistocene chiton bed at Point Firmin, Los Angeles County (Chace).
Recent: San Pedro to San Diego, California (Dall).

This is a very small species (alt. 5-7½ mm., diam. 5½-7½ mm.), with fine spiral riblets and rows of granules. It is a shallow-water form.

Calliostoma splendens Carpenter

Calliostoma splendens Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 653, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 156, 1865; Dall, Amer. Journ. Conch., Vol. 7, p. 126, Nov., 1871; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 362, 1889, in synonymy of *costatum;* Dall, Bull. 112, U. S. Nat. Mus., p. 177, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 182, pl. 98, fig. 1, 1927.

Type specimen: In the California State Collection, No. 530*a*, *fide* Oldroyd, at the University of California ?

Type locality: Monterey, California.

Pleistocene: Upper San Pedro fauna of Santa Monica, one specimen (apparently of this species or a new variety, in the Oldroyd Collection at Stanford University).
Recent: Monterey to San Diego, California (Dall).

This is a small, spirally ribbed, granulose form, formerly thought to be the young of *costatum.* It is well figured by Williamson, and the figure is reproduced by Oldroyd. Mr. Willett has obtained this species only by dredging. Some specimens are difficult to distinguish from *C. supragranosum.*

Clark has described a variety[1] of this species from the upper Miocene of the region east of San Francisco Bay.

Genus TURCICA A. Adams, 1854

Turcica A. Adams, Proc. Zool. Soc. London, Part 22, p. 37, 1854, sole species *T. monilifera* A. Adams, *loc. cit.* and pl. 27, fig. 1; Dall, U. S. Geol. Surv., Prof. Paper 59, p. 96, 1909.
Ptychostylis Gabb, Proc. Calif. Acad. Sci., Vol. 3, p. 187, 1865.
Thalotia of Cooper, 1867, but not of Gray, 1847, *fide* Dall, 1909.

Type (by monotypy), *Turcica monilifera* A. Adams, *op. cit.*, p. 37, pl. 27, fig. 1, Moreton Bay, Australia; Recent.

Shell conoidal, thin, subdiaphanous, imperforate; whorls with transverse series of granules, the last rounded at the periphery; columella solid, spirally twisted at the upper part, ending below or anteriorly in an obtuse prominent point; outer lip thin, simple, acute. (Adams.)

This genus is closely allied to *Calliostoma*, from which it differs in its twisted columella, thickened below.

Turcica caffea Gabb

Turcica (*Ptychostylis*) *caffea* Gabb, Proc. Calif. Acad. Nat. Sci., Vol. 3, p. 187, 1865; Geol. Surv. Calif., Palæo., Vol. 2, pt. 1, p. 16, pl. 3, fig. 27, 1866; pt. 2, p. 84, 1868-9.
Thalotia caffea Gabb, Cooper, Geog. Cat. West Coast Shells, p. 26, 1867; 7th Ann. Rept. Calif. St. Mineralogist, p. 267, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 327, 1903.
Calliostoma (*Turcica*) *caffea* Pilsbry, Tryon's Man. Conch., Vol. 11, p. 416, 1889.
Turcica caffea Gabb, Dall, Bull. 112, U. S. Nat. Mus., p. 177, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 192, 1927.

Pleistocene: "Pliocene" of Deadman Island; one specimen from the lower San Pedro series of Deadman Island, Los Angeles County (Arnold).
Recent: San Pedro, California, to Cape San Lucas, Lower California, Mexico (Dall).

This shell looks something like a *Calliostoma,* but has two twisted fold-like protuberances on the columella and a conspicuously channeled or depressed suture.

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[1] *Calliostoma splendens* Carpenter, var. *diabloensis* Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 482, pl. 65, fig. 21, 1915.

Turcica gabbi Dall

Turcica gabbi Dall, U. S. Geol. Surv., Prof. Paper 59, pl. 4, fig. 5, pl. 6, fig. 11, 1909.

Type specimen: In the U. S. National Museum, No. 153,968.

Type locality: Coos Bay, Oregon; Miocene.

Miocene: Coos Bay and south of Fossil Point, Oregon (Dall).

This species, the possible precursor of *T. caffea* Gabb, is more elevated and has simpler sculpture than Gabb's species.

Genus CIDARINA Dall, 1909

Cidarina Dall, U. S. Geol. Surv., Prof. Paper 59, p. 98, April, 1909.

Type (by original designation), *Margarita cidaris* A. Adams.

"Shell large, whitish, unicolor, with strong spiral sculpture, sharply nodose, the umbilicus closed by a reflexed layer of callus, the suture channeled." (Dall, 1909.)

This genus was originally differentiated as a section of *Margarites* Leach, in Gray, 1847. It is distinguished from *Solariella* by its closed umbilicus.

It appears that the section *Callitropis* Sequenza, 1903, will have to take the place of *Solaricida* Dall, 1919.

Cidarina cidaris (A. Adams)

Plate 32, Figure 22

Margarita cidaris A. Adams, in Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 653, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 426, Vol. 15, p. 29, 1865; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 249, 1888; Calif. St. Mining Bureau, Bull. 4, Pt. 3, p. 27, 1894.

Turcicula (?) *cidaris* (A. Adams) Carpenter, Pilsbry, Tryon's Man. Conch., Vol. 11, p. 331, no figure, 1889.

Solariella oxybasis Dall, Proc. U. S. Nat. Mus., Vol. 12, p. 352, pl. 12, fig. 6, 1889, *fide* Cooper, 1889.

Solariella cidaris A. Adams, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 202, pl. 22, fig. 4, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 334, pl. 7, fig. 11, 1903.

Cidarina cidaris A. Adams, Dall, Bull. 112, U. S. Nat. Mus., p. 177, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 193, pl. 91, fig. 7, 1927.

Type locality: Near Neah Bay, Washington; Recent.

Pliocene: San Marcial, Lower California, Mexico (Carpenter). This occurrence may be Pleistocene.
Pleistocene: "Pliocene" of Deadman Island, rare, "about a dozen specimens" (Arnold).
Recent: Kasaän Bay, Alaska, to Cape San Quintin, Lower California (Dall).

The ventricose whorls, regularly increasing in size from the minute apex, the thin shell, and nodose, partially cancellate sculpture serve to distinguish this species. The umbilicus is sometimes partly open behind the reflected columellar lip.

Genus SOLARIELLA S. Wood, 1842

Solariella S. Wood, Ann. Mag. Nat. Hist., Vol. 9, p. 531, 1842, sole species, *S. maculata* S. Wood; Cossmann, Ess. Paléo. Comp., Vol. 11, pp. 259-261, 1918; Woodring, Carnegie Inst., Publ. No. 385, p. 431, 1928.

Type (by monotypy), *S. maculata* S. Wood; Pliocene of England.

Shell small, spire low, inner layer nacreous, umbilicus very wide and deep. Aperture subcircular, almost parallel to the vertical axis of shell, peristome attached to parietal wall along only small part of its circumference. Outer lip, as viewed from above, slightly convex forward between suture and periphery of body whorl. Basal lip virtually straight. Sculpture consisting of spiral threads modified by fine axial threads. (Woodring.)

Range: Cretaceous to Recent.

A number of species of *Solariella* have been described from the Eocene of California and Washington. It is strange that but one species has as yet been reported from the Pliocene.

Solariella peramabilis Carpenter

Solariella peramabilis Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 653, 1864; Proc. Calif. Acad. Nat. Sci., Vol. 3, p. 156, 1864; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 265, 1888; Pilsbry, Tryon's Man. Conch., Vol. 11, p. 312, pl. 67, figs. 59-61, 1889; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 202, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 335, pl. 7, fig. 2, 1903; Dall, Bull. 112, U. S. Nat. Mus., p. 177, pl. 17, fig. 8, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 195, pl. 91, fig. 8, pl. 101, fig. 7, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Small, turbinate, with a few granulose, widely spaced spiral riblets, more numerous and more closely spaced on the base of the body whorl; umbilicus wide open, one or two basal riblets ascending spirally within. Average specimens measure 12 mm. in axial length; apical angle about 82°.

Pliocene: Pico of Ventura district (Waterfall).
Pleistocene: "Pliocene" of Deadman Island, Los Angeles County, rare, "four specimens" (Arnold).
Recent: Forrester Island, Alaska, to San Diego and the Coronado Islands (off San Diego); also Japan (Dall).

Genus **MARGARITES** Leach in Gray, 1847

Margarita Leach, Thompson's Ann. Phil., Vol. 14, p. 202, 1819, not of Leach, Zool. Misc., Vol. 1, p. 107, 1814, a pearl oyster; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, pp. 13, 285, 1889.
Margarites Leach MS., Gray, Ann. Mag. Nat. Hist., Vol. 20, p. 271, 1847; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 406, 1892; U. S. Geol. Surv., Prof. Paper 59, p. 97, 1909.
Eumargarita Fischer, Man. Conchyl., p. 825, 1885.

Type (by monotypy), *Helix margarita* Montagu = *Trochus helicinus* Fabricius, 1780, = *? Turbo helicinus* Phipps, 1774, a Recent species of the northern Atlantic, Arctic, and Pacific coast south to Catalina Island, California.

Shell umbilicate, orbicular, conoidal or depressed, thin; not variegated; whorls rounded, smooth or spirally lirate; aperture subcircular, peristome simple, acute, the margins approaching; columella arcuate, simple, thin. (Pilsbry.)

The typical section of this genus is a boreal group, containing a number of supposed species and varieties, many of which are difficult to differentiate. The pearly shell within the aperture of some species is very pretty.

Margarites, s. s., has a depressed shell of but few whorls. *Lirularia* and *Pupillaria* have rather prominent spiral sculpture and a more elevated spire.

Subgenus **PUPILLARIA** Dall, 1909

Pupillaria Dall, U. S. Geol. Surv., Prof. Paper 59, p. 97, 1909.

Type (by original designation), *Trochus pupillus* Gould, Bering Sea south; Recent.

Shell dull, trochiform, unicolor, strongly spirally striated, sometimes radiately ribbed, and with more numerous whorls. Chiefly temperate seas. (Dall.)

There is less difference between *Pupillaria* and *Lirularia* than between either of the two and *Margarites, s. s.*

Cidarina Dall, described as a section at the same time as the foregoing, is very distinct. *Lirularia* is smaller than *Pupillaria.*

Margarites (Pupillaria) pupillus (Gould)

Trochus pupillus Gould, Proc. Boston Soc. Nat. Hist., Vol. 3, p. 91, 1849, "New Zealand"; U. S. Expl. Exped., Vol. 12, Mollusca, p. 186, 1852, Atlas, fig. 208, 1856.

Margarita pupilla Gould, Dall, Amer. Journ. Conch., Vol. 7, p. 127, Nov., 1871; Cooper, 7th Ann. Rept. Calif. St. Mineralogist, p. 249, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 295, pl. 44, figs. 29-32, 1889; Keep, West Coast Shells, p. 78, fig. 63, 1888, 1892; Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 202, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 333, pl. 10, fig. 15, 1903; S. S. Berry, Nautilus, Vol. 22, p. 38, 1908.

Margarites (Pupillaria) pupilla Gould, Dall, U. S. Nat. Mus., Bull. 112, p. 178, pl. 17, figs. 2, 10, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 200, pl. 101, figs. 2, 3, 1927.

Shell small, ovate-conic, rather solid; whorls five, convex, flattened slightly above, forming a narrow, tabulated band just below the suture; body whorl obtusely angulated; surface sculptured with small, flattened, subequal, equidistant, revolving ribs, five on the upper whorls; interspaces ornamented by fine, oblique growth lines; base of body whorl nearly flat, and ornamented with numerous fine, revolving lines, which become coarser near the umbilicus; suture deeply impressed, distinct; aperture circular; columella somewhat arcuate; umbilicus small, groove-like; outer lip sharp; nacreous layer on the inner lip. Dimensions: Alt. 5.8 mm.; lat. 8 mm.; defl. 67 degrees. (Arnold, slightly altered.)

Type specimen: In the U. S. National Museum.

Type locality: "New Zealand." Oldroyd explains the mistake in type locality as caused by transportation of the type specimen in ballast.

Pliocene: Santa Barbara formation, upper Pliocene, at Bath-house Beach, Santa Barbara (Cooper; Arnold; S. S. Berry).

Pleistocene: "Pliocene" at Deadman Island, Los Angeles County (Arnold).

Recent: Nunivak Island, Bering Sea, to San Pedro, California; ? San Diego in deep water (Dall).

Margarites (Pupillaria) cinereus (Couthouy)

Margarita striata Broderip and Sowerby, Zool. Journ., Vol. 4, p. 371, 1829, (not *M. striata* Leach, Appendix to Ross's Voy. of Discovery H. M. S. Isabella and Alexander, Ed. 2, 1819); Dall, U. S. Geol. Surv., 17th Ann. Rept., Pt. 1, p. 845, 1896.

Turbo cinereus Couthouy, Boston Journ. Nat. Hist., Vol. 3, p. 99, pl. 3, fig. 9, 1838.

Margarita cinerea Couthouy, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 291, pl. 37, fig. 5, pl. 44, figs. 20, 25, pl. 60, fig. 29, 1889.

Margarites (Pupillaria) cinerea Couthouy, Dall, Bull. 112, U. S. Nat. Mus., p. 178, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 201, 1927.

Type specimen: In the Couthouy Collection, Boston ?

Type locality: Massachusetts Bay.

Miocene: "Miocene" of St. Paul Island and of Unalaska (Dall, 1896).

Recent: Bering Strait to Port Etches, Alaska; circumboreal (Dall, 1921).

This species is well supplied with synonyms. We have seen no authentic specimens.

Subgenus **LIRULARIA** Dall, 1909

Lirularia Dall, U. S. Geol. Surv., Prof. Paper 59, p. 98, April, 1909.

Type (by original designation), *Margarita lirulata* Carpenter; Recent, Alaska to San Diego, California.

Shell small, dull-surfaced, with variable color patterns, strong spiral sculpture, and delicate axial sculpture. Tropical and warm temperate seas. (After Dall, alt.)

Margarites (Lirularia) lirulatus (Carpenter)

Margarita lirulata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 653, 1864; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 11, p. 296, pl. 65, figs. 81, 82, 87, 1889.

Margarites lirulata Carpenter, Dall, U. S. Geol. Surv., Prof. Paper 59, p. 98, 1909.

Margarites (Lirulario) lirulata Carpenter, Dall, Bull. 112, U. S. Nat. Mus., p. 179, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 207, pl. 101, fig. 1, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Margarites magna T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 36, pl. 2, figs. 2, 3, 5, January, 1925.

Type specimen: In the U. S. National Museum.

Type locality: Puget Sound.

Pliocene: Pico formation, near Ventura (Waterfall).
Pleistocene: Saugus formation, near Ventura (Waterfall); San Pedro, California (in the collection of George Willett).
Recent: Port Etches, Alaska, to San Diego, California (Dall, 1921).

This species usually has rather widely spaced spiral ribs, three on the penultimate whorl, more on the body whorl, closer together around the umbilicus, which is open. The aperture is almost circular. The sculpture of *lirulatus* is said to be quite variable, sometimes obsolete. It may be closely related to *optabilis* (Carpenter).

In this species as in many others there are occasional abnormally large individuals or even schools of such exceptional specimens which do not have any claim to nomenclatorial recognition. They appear both in the fossil and in the Recent fauna and probably reflect some condition peculiarly favorable to increase in size. "*Margarites magna*" T. S. Oldroyd applies to large sized specimens of *M. lirulatus*.

Margarites (Lirularia) condoni Dall

Margarites (Lirularia) condoni Dall, U. S. Geol. Surv., Prof. Paper 59, p. 98, pl. 6, figs. 7, 8, April, 1909.

Type specimen: In the U. S. National Museum, No. 153,922.

Type locality: Coos Bay, Oregon; upper Miocene.

Miocene: At the type locality (Dall).

This species has a less depressed body whorl than *M. pupillus,* but seems to be related. Dall gives it an elaborate description and places it in *Lirularia.*

Margarites (? Lirularia) johnsoni Arnold

Margarites johnsoni Arnold, U. S. Geol. Surv., Bull. 396, p. 69, pl. 15, fig. 6, January 15, 1910; Bull. 398, pl. 37, fig. 6, 1910; Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 221, 1917.

Type specimen: In the U. S. National Museum, No. 165,663.

Type locality: On Jasper Creek just above Jacalitos Creek, Coalinga district, California; lower Pliocene.

Pliocene: Jacalitos formation, Coalinga district (Arnold); "*Chione elsmerensis* zone," lower Etchegoin Pliocene, Coalinga district, common (Nomland).

According to Arnold, this species can be distinguished from *M. pupillus* (Gould) by "its smaller size, less convex whorls, less conspicuous suture, and much coarser but fewer spiral lines on base. The species is easily distinguishable from *Leptothyra* by its higher spire, perforate umbilicus, and more prominent oblique incremental sculpture."

Margarites (**Lirularia**) **optabilis** (Carpenter) variety **knechti** (Arnold)

Margarita optabilis Carpenter, var. *knechti* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 332, pl. 5, fig. 14, 1903.
Margarita optabilis knechti Arnold, Berry, Nautilus, Vol. 22, p. 38, 1908.
Margarites optabilis knechti Arnold, Dall, U. S. Nat. Mus., Bull. 112, p. 179, 1921.

Shell small, conical, thin; apical whorls turbinated; whorls five; upper whorls rather angular, slightly tabulated above; body whorl rounded, slightly angulated at base; two prominent spiral ridges, one at angle of whorl, the other near anterior margin; between these two ridges a slight concave surface sometimes ornamented with faint spiral ridges; oblique growth lines quite prominent; suture impressed and distinct; base of body whorl only slightly convex and ornamented by five spiral ridges; umbilicus large, deep, effuse, smooth; aperture subrotund; inner lip incrusted and projecting slightly over umbilicus. Dimensions: Alt. 8.5 mm.; lat. 8 mm.; body whorl 6.5 mm.; aperture 4.5 mm.; defl. 70 degrees. (Arnold, alt.)

Type specimen: In the U. S. National Museum.

Type locality: San Pedro, Los Angeles County; Pleistocene.

Pliocene: Santa Barbara formation, upper Pliocene, Bath-house Beach outcrop, Santa Barbara (Berry).
Pleistocene: "Common in lower and rare in upper San Pedro series of San Pedro" (Arnold).

This variety is very close to the typical form[1] but appears to be a little higher spired.

Margarites (**Lirularia**) **optabilis** (Carpenter) variety **nodosus** (Arnold)

Margarita optabilis Carpenter, var. *nodosa* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 332, pl. 5, fig. 13, 1903.
Margarites (*Lirularia*) *optabilis nodosa* Arnold, Dall, U. S. Nat. Mus., Bull. 112, p. 179, 1921.

Type specimen: In the U. S. National Museum.

Type locality: San Pedro, Los Angeles County; lower Pleistocene.

Pleistocene: Lower San Pedro series of San Pedro and Deadman Island, Los Angeles County (Arnold).

"This variety is distinguishable by its simple conical shape, flat whorls, and nodose ridges." (Arnold.)

Margarites (**Lirularia**) **parcipictus** (Carpenter) variety **pedroanus** (Arnold)

Margarita parcipicta Carpenter, var. *pedroana* Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 333, pl. 5, fig. 16, 1903.
Margarites (*Lirularia*) *parcipicta pedroana* Arnold, Dall, U. S. Nat. Mus., Bull. 112, p. 179, 1921.

Shell small, thin, globular, conical; spire elevated, subacute; whorls four, rounded, tabulated near posterior margin; four spiral ridges on upper whorls; suture deeply impressed and distinct; base of body whorl rounded and ornamented by fine spiral ridges; umbilicus deep and effuse; aperture subcircular. Dimensions: Alt. 5.5 mm.; lat. 5.5 mm.; body whorl 4.5 mm.; aperture 3 mm.; defl. 80 degrees. (Arnold.)

Type specimen: In the U. S. National Museum.

Type locality: San Pedro, Los Angeles County; Pleistocene.

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro; upper San Pedro series at Deadman Island, San Pedro, and Los Cerritos (Arnold).

The typical variety, which is figured by Dall,[2] ranges in the Recent fauna from Sitka, Alaska, to San Martin Island, Lower California, Mexico (Fred Baker, MS.).

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[1] Brit. Assn. Adv. Sci., Rept. for 1863, p. 653, 1864; Proc. Calif. Acad. Nat. Sci., Vol. 3, p. 214, 1865; figured by Dall, U. S. Nat. Mus., Bull. 112, p. 179, pl. 17, fig. 7, Feb., 1921; Recent, Santa Barbara to San Pedro, California.

[2] Bull. 112, U. S. Nat. Mus., p. 179, pl. 17, fig. 3, 1921.

Family CYCLOSTREMATIDAE

Genus VITRINELLA C. B. Adams, 1850

Vitrinella C. B. Adams, Monograph of *Vitrinella*, p. 3, 1850; Pilsbry, Tryon's Man. Conch. Ser. 1, Vol. 10, p. 15, 1888; Bush, Trans. Conn. Acad. Arts and Sci., Vol. 10, p. 105, 1897; Woodring, Carnegie Inst., Publ. No. 385, p. 438, 1928.

Type (by subsequent designation, Bush, 1897), *Vitrinella helicoidea* C. B. Adams, figured by Pilsbry, *op. cit.*, p. 102, pl. 34, figs. 40, 41, 1888, Jamaica; Recent.

Shell small, thin, with a *Helix*-like low spire and a very wide umbilicus; sculpture absent except for growth lines; aperture ovate, with margin projecting forward between the suture and the periphery of the body whorl; callus deposit on parietal wall.

It is probable that *Vitrinella* should be considered a subgenus of *Cyclostrema*.

Section VITRINELLA, s. s.

Vitrinella williamsoni Dall

Vitrinella williamsoni Dall, Proc. U. S. Nat. Mus., Vol. 15, p. 202, pl. 21, figs. 2, 3, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 335, 1903; Dall, U. S. Nat. Mus., Bull. 112, p. 181, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, p. 216, pl. 106, figs. 4, 6, 1927.

Type specimen: In the U. S. National Museum, No. 106,856.

Type locality: San Pedro, California; Recent.

Pleistocene: Lower San Pedro series of Deadman Island, "rare"; upper San Pedro series of San Pedro, Los Angeles County (Arnold).
Recent: San Pedro, California (Dall, 1921).

This is a strongly flattened species. Arnold found nearly perfect specimens in the lower San Pedro series of Deadman Island.

Vitrinella thomasi Bartsch

Vitrinella thomasi Bartsch, Proc. Biol. Soc. Wash., Vol. 31, p. 79, July 29, 1918.

Pleistocene: Nob Hill cut, San Pedro, Los Angeles County (Bartsch).

This form is like *V. williamsoni* Dall, but it is smaller and less depressed. It is probable that it should be considered a variety or variation of the latter.

Vitrinella eshnauri Bartsch

Vitrinella eshnauri Bartsch, Proc. U. S. Nat. Mus., Vol. 32, p. 168, text figs. 2*a-c*, February 8, 1907; Berry, Nautilus, Vol. 21, p. 46, 1907; Dall, U. S. Nat. Mus., Bull. 112, p. 181, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 247, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 217, pl. 106, figs. 5, 7, 9, 1927.

Type specimen: In the U. S. National Museum, No. 127,557.

Type locality: San Pedro, California; Recent.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro (Bartsch; Dall); Monterey (Berry).

This is a higher spired shell than *V. williamsoni*. The aperture is nearly circular.

Section DOCOMPHALA Bartsch, 1907

Shell like that of typical *Vitrinella* except that the inner half of the columellar wall of the umbilicus is marked by strong, oblique, rounded ribs, and the whorls of the spire may show axial ribs.

Vitrinella stearnsi Bartsch

Vitrinella (*Docomphala*) *stearnsi* Bartsch, Proc. U. S. Nat. Mus., Vol. 32, p. 169, text figures 4*a-c*, February 8, 1907; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 218, pl. 106, figs. 11, 13, 14, 1927.
Vitrinella stearnsi Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 181, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 247, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey, California (Dall, 1921).

This species is bluntly carinated at the basal margin of the umbilical opening.

Genus DELPHINOIDEA Brown, 1827

Delphinoidea Brown, Illust. Conch. Gt. Brit. Irel., p. 4, pl. 51, fig. 32, 1827; Ed. 2, p. 20, 1844; Gray, Proc. Zool. Soc. London for 1847, p. 152, 1847.

Type (by subsequent designation, Gray, 1847), *Helix serpuloides* Montagu, figured by Brown, *op. cit.*, Ed. 2, p. 21, pl. 8, figs. 40, 41, 1844, coasts of Europe; Recent.

Shell small, *Helix*-like, smooth or spirally striated, umbilicus large, wide.

This genus should be compared with *Skenea* Fleming. It is at least in part the *Cyclostremella* as used by Bartsch, not *Cyclostremella* Bush. *Delphinoidea* Brown, 1827, does not seem to have had a prior generic use.

Delphinoidea coronadoensis Arnold

Delphinoidea coronadoensis Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 320, 1903.

Shell minute, orbicular, depressed, milk-white, rather thick for size of shell; spire flattened beneath plane of upper periphery of the body whorl; whorls two and one-half, nearly circular in cross-section; surface ornamented by numerous subequal, rounded spiral ridges, and very minute transverse lines, the whole giving the surface a cancellated appearance; irregular lines denoting interruption in growth are common on the body whorl; suture deeply appressed; umbilicus wide, deep; aperture suboval; peristome continuous, rather thick, slightly effuse. Dimensions: Maximum diameter, 2 mm.; altitude, 0.9 mm. (Arnold.)

Type locality: Spanish Bight, North Island, San Diego, California; Pleistocene.

The typical variety appears to have stronger striations and more deeply depressed[1] sutures than variety *californica* Bartsch. They are very closely related.

Delphinoidea coronadoensis Arnold variety **californica** (Bartsch)

Cyclostremella californica Bartsch, Proc. U. S. Nat. Mus., Vol. 32, p. 174, text figures 10*a-c*, February 8, 1907; Dall, U. S. Nat. Mus., Bull. 112, p. 182, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 223, pl. 106, figs. 1-3, 1927.

Type locality: Long Beach, California; Recent.

Pleistocene: San Diego, California (Bartsch).
Recent: Monterey, to San Diego, California (Bartsch).

This variety is very close to the typical form, and larger collections probably will show that individual variation accounts for the differences. If so, *californica* should be synonymized. Specimens in the collection of Mr. George Willett of the Los Angeles Museum suggest that the variety *californica* has less depressed sutures and less distinct spiral striations.

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[1] Arnold stated that the sutures were "deeply appressed," possibly meaning *depressed*.

Superfamily Zygobranchia

Family HALIOTIDAE

Genus HALIOTIS Linnæus, 1758

The genus *Haliotis* Linnæus may be subdivided into a number of sections (or subgenera) which cannot be discussed here. The species listed below belong to *Haliotis, sensu lato,* though the modern tendency toward fine subdivisions may result in their separation into two groups.

So far as known, *Haliotis* first made its appearance in California in the upper Cretaceous, one species having been described from the Chico formation of Point Loma, San Diego, by F. M. Anderson.[1] At least one species is known from the Miocene of southern California and several occur in the Pliocene and Pleistocene.

Abalones are a source of food in California and Lower California, but the danger of extinction has required legal protection for the species in the United States. The California Recent species are shallow-water forms, sedentary in habits, and feed on sea lettuce, eel grass, rock kelps, and diatoms.[2]

Haliotis corrugata Gray

Haliotis corrugata Gray, in Wood's Index Test., Suppl., pl. 8, fig. 5, 1828; Reeve, Conch. Icon., Vol. 3, *Haliotis*, pl. 4, fig. 12, 1846; Sowerby, Thes. Conch., Vol. 5, p. 19, fig. 26 (excl. var.), 1882; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 80, pl. 5, fig. 24, 1890; Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 236, 1927.

Haliotis nodosa Philippi, Zeitschr. f. Malak, p. 149, October, 1845; Abbild. Beschreib., Vol. 2, p. 157, pl. 5, and pl. 6, fig. 1, 1847.

Shell large, subcircular, or short oval, very convex, like a half-globe; surface corrugated, the wrinkles nodose; perforations elevated, tubular, three open; muscle scar distinct, roughened. Length, 155 mm.; width, 122 mm.; convexity, 57 mm. (After Pilsbry.)

Pliocene: Middle Pliocene of S. D. S. N. H. locality 223, O'Hare Canyon, Ventura County, one specimen (H. R. G.); in excavation for Los Angeles Public Library, Los Angeles, California, thirty feet below surface, lower part of upper Pliocene (in collection of Los Angeles Museum).

Recent: Monterey, California, to San Quintin Bay, Lower California (Dall).

This species is easily distinguished by its outline and convexity, its rough surface, and tubular perforations. The one specimen collected in O'Hare Canyon, Santa Paula Quadrangle, broke into many pieces when being extracted from the conglomerate bed in which it was found, but its shape and a single very tubular perforation which survived served to identify it.

Haliotis rufescens Swainson

Haliotis rufescens Swainson, Cat. Shells Bligh, Appendix, p. 2, 1822; Reeve, Conch. Icon., Vol. 3, *Haliotis*, pl. 2, fig. 6, 1846; Sowerby, Thes. Conch., Vol. 5, p. 18, fig. 35, 1882; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 82, pl. 20, fig. 11, 1890; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 306, pl. 33, 1918; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 232, pl. 90, fig. 2, pl. 89, fig. 2, 1927; Bonnot, Calif. Fish and Game, Vol. 16, p. 20, text fig. 10, 1930.

? *Haliotis ponderosa* Adams, Amer. Journ. Sci. Arts, Ser. 2, Vol. 6, p. 138, 1848, *fide* Pilsbry, 1890.

? *Haliotis* cf. *rufescens* Swainson, Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 449, 1926.

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[1] Cretaceous Deposits of the Pacific Coast, Proc. Calif. Acad. Sci., Ser. 3 (Geology), Vol. 2, p. 75, pl. 9, fig. 183, December 24, 1902. *Haliotis lamaensis* F. M. Anderson, from the "Lower Chico" of Point Loma. The type specimen is preserved in the paleontological collections of the California Academy of Sciences, having endured the San Francisco earthquake and fire of 1906. It is small in size and may be a young individual or possibly not a true *Haliotis*.

[2] See "Abalones in California" by Paul Bonnot, California Fish and Game, Vol. 16, no. 1, pp. 15-23, text figures, January, 1930.

Shell large, heavy and solid, oval, not very convex; sculpture consisting of unequal spiral cords and threads, finer than in *H. fulgens*, and wide, low, obliquely radiating waves. Below the row of holes there is a depression, followed by a low ridge bearing usually large, low, obtuse tubercles. Spire not projecting above general curve of the back; muscle scar large, a portion of it roughened by coarse raised cords which take a spiral direction. The columellar plate is rather narrow, its lower part sloping in somewhat. Perforations large, tubular or irregular, 3 or 4 open. Length, 185-235 mm.; width, 150-185 mm.; convexity, 40-58 mm. (Modified from Pilsbry.)

Pliocene: S. D. S. N. H. locality 225, between Timber Canyon and Santa Paula Creek, Ventura County, fragments of one specimen (H. R. G.); ? Cedros Island, Lower California, Mexico (Jordan and Hertlein).

Pleistocene: Chiton bed at Point Firmin, Los Angeles County (Chace).

Recent: Bodega Bay, California, to La Paz, Lower California, Mexico (Dall).

This species is distinguished by its large, heavy shell, light spiral sculpture, and radiating waves. Living specimens of this species are known as the red abalone, on account of the dull brick-red color of the exterior of the shell. Curtner[1] determined that California specimens six inches in diameter were nine years old, those eight inches in diameter, thirteen years old.

Haliotis fulgens Philippi

Haliotis fulgens Philippi, Zeitschr. f. Malak., p. 150, October, 1845; Abbild. Beschreib., Vol. 2, p. 220, pl. 7, pl. 8, fig. 1, 1847; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 574, 1864; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 81, pl. 12, figs. 61, 62, 1890; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 336, 1903; Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 306, 1918; Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 233, 1927; Bonnot, Calif. Fish and Game, Vol. 16, p. 18, 1930.

Haliotis splendens Reeve, Conch. Icon., Vol. 3, *Haliotis*, pl. 3, fig. 9, 1846; Proc. Zool. Soc. London for 1846, p. 54; and of authors generally.

Haliotis planilirata Reeve, *op. cit.*, pl. 3, fig. 62, (young), *fide* Pilsbry, Tryon's Man. Conch., pl. 19, fig. 9, 1890.

Pliocene: S. D. S. N. H. locality 202, lower Pliocene of Elsmere Canyon, Los Angeles County, one specimen (H. R. G.).

Pleistocene: Upper San Pedro series of Deadman Island, Los Angeles County; also Spanish Bight, San Diego, one specimen from each locality (Arnold).

Recent: Farallone Islands (Carpenter) and Catalina Island, California, to Gulf of California, Mexico (Dall).

This species is distinguished by its spiral sculpture, moderate convexity, angle at the row of holes, and keel. Recent specimens are known as the green abalone, having been extensively collected for food in southern California and Lower California, Mexico. The species is uncommon north of Point Conception.

Arnold stated that Cooper's records of *Haliotis* referred to Indian kitchen midden deposits in which abalones are sometimes found.

Haliotis cracherodii Leach

Haliotis cracherodii Leach, Zool. Misc., Vol. 1, p. 131, 1814; Reeve, Conch. Icon., Vol. 3, *Haliotis*, pl. 7, fig. 23, 1846; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 79, pl. 10, figs. 52, 53, 1890; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 183, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 230, 1927; Bonnot, Calif. Fish and Game, Vol. 16, pp. 20, 22, text fig. 11, 1930.

Haliotis cracherodii var. *splendidula* Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 198, 1892.

Haliotis cracherodii, var. *holzneri* Hemphill, Trans. San Diego Soc. Nat. Hist., Vol. 1, no. 2, p. 4, 1907; Dall, U. S. Nat. Mus., Bull. 112, p. 183, pl. 20, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 231, 1927.

Haliotis cracherodii, new form *imperforata* Dall, Proc. U. S. Nat. Mus., Vol. 56, p. 370, Aug. 30, 1919.

Haliotis cracherodii imperforata Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 231, 1927.

Haliotis cracherodii splendidula Williamson, Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 231, 1927.

Haliotis cracherodii lusus Finlay, Trans. New Zealand Inst., Vol. 57, (for 1926), p. 492, 1927, new name for *H. c. imperforata* Dall, preoccupied.

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[1] W. W. Curtner, Master of Arts Thesis, Stanford University, May, 1917.

Pleistocene: Chiton Bed, Point Firmin, Los Angeles County (Chace).
Recent: Coos Bay, Oregon, to Santa Rosalia, Lower California, Mexico (Dall, 1921).

The black abalone is easily distinguished by its dark color and by the nearly smooth exterior surface of the shell. It is inferior in food qualities to the green abalone, *H. fulgens* Philippi. Bonnot found the species exceedingly abundant at low tide on the rocks on San Miguel Island. It seems to favor rocks not thickly covered with algæ and is supposed to subsist on diatoms.

The occasional shells which have no open holes are abnormal individuals. They have been uselessly named as varieties three times. Some shells have a supplementary deposit of brilliant pearly appearance in the center of the interior of the shell which mislead Williamson to name them as a distinct variety (*splendidula*). Such peculiarities in the shell occur sporadically and have no claim to taxonomic recognition. A similar phenomenon occurs in *H. californiensis* and perhaps in others also.

Haliotis californiensis Swainson[1] may be a distinct species. It has numerous (about 14) small round holes, the margins of which stand out but very little from the exterior surface of the shell. Some individuals have a supplementary shell deposit in the interior which is an individual peculiarity forming the basis of the useless name *bonita* Orcutt.[2]

Family FISSURELLIDAE

Shell conical, limpet-shaped, non-spiral (but with a spiral nucleus), having a perforation, anterior slit, notch, or emargination for the passage of the anus; not nacreous; having a horseshoe-shaped impression of the adductor muscle; bilaterally symmetrical. (Pilsbry, 1890.)

Subfamily Fissurellinae

Apex of shell wholly removed by the anal perforation, which is bounded inside by a callus with entire margins, not truncated or excavated posteriorly. Central tooth of the radula narrow. Shell wholly external, capable of containing the entire animal. (Pilsbry.)

Genus FISSURELLA Bruguière, 1789

Fissurella Bruguière, Encycl. Méthod., Vers, Vol. 1, p. xiv, 1789, genus without species; Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 78, 1799; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 142, 1890; Woodring, Carnegie Inst., Publ. No. 385, p. 449, 1928.

Type (by monotypy, Lamarck, 1799), *Patella nimbosa* Linnæus, figured by Pilsbry, *op. cit.*, p. 163, pl. 36, fig. 32, 1890, Caribbean region; Recent.

Fissurella volcano Reeve

Fissurella volcano Reeve, Conch. Icon., Vol. 6, *Fissurella*, pl. 4, fig. 2, 1849; Sowerby, Thes. Conch., Vol. 3, p. 192, pl. 239, fig. 87, 1862; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 240, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 156, pl. 62, figs. 16-18, 1890; Keep, West Coast Shells, p. 96, fig. 81, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 340, 1903; Keep, West American Shells, p. 259, fig. 291, 1904; Revised Ed., p. 249, fig. 248, 1911; Dall, Nautilus, Vol. 32, p. 24, 1918; E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919; Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; Stephens, Trans. San Diego Soc. Nat. Hist., Vol. 5, p. 253, 1929.

Fissurella ornota Nuttall MS., Carpenter, Proc. Zool. Soc. London for 1856, p. 222, *fide* Pilsbry, 1890.

Fissurella volcano Reeve, variety *crucifera* Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 256, 1908.

Subemarginula golischæ Dall, Nautilus, Vol. 30, p. 61, October, 1916.

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[1] Zool. Illustr., Vol. 2, pl. 80, December, 1821; Reeve, Conch. Icon., Vol. 3, *Haliotis*, pl. 8, fig. 26, 1846; Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 232, pl. 86, figs. 1, 2, 1927.

[2] West American Scientist (San Diego), Vol. 10, no. 5, p. 30, 1900.

Fissurella volcano crucifera Dall, U. S. Nat. Mus., Bull. 112, p. 184, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 246, 1927.

Hemitoma golischæ Dall, U. S. Nat. Mus., Bull. 112, p. 186, pl. 5, fig. 2, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 238, pl. 85, fig. 2, 1927.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, common; upper San Pedro series at Deadman Island, Los Cerritos, Crawfish George's, and San Pedro (Arnold); chiton bed on Point Firmin (Chace); Pacific Beach (Arnold) and the west side of Point Loma (Stephens), San Diego; Magdalena Bay, Lower California, Mexico (Dall, 1918).

Recent: Crescent City, California, to Panama (Dall, 1921).

The form called variety *crucifera* is an individual variant with radial white bands; it occurs sporadically and is of no taxonomic value. Rarely, some individuals show a partial obsolescence of the apical perforation; the extreme form with an entirely imperforate apex was named *Subemarginula golischæ* by Dall. The type of the latter is in the U. S. National Museum.

Subfamily FISSURELLIDINAE

Animal much too large to be included in the shell, even when contracted in preservatives. Rhachidian tooth far broader than the laterals, not narrowed above. Shell with the apex removed by a large perforation, which is bounded inside by an entire, not truncated, callus rim. (From Pilsbry, 1890.)

Genus MEGATHURA Pilsbry, 1890

Megathura Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 182, 1890; Iredale, Proc. Malac. Soc. London, Vol. 12, p. 328, 1917.

Type (by monotypy), *Megathura californica* Nuttall MS., Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 182, 1890, = *Megathura crenulata* (Sowerby).

Megathura crenulata (Sowerby)

Fissurella crenulata Sowerby, Cat. Tankerville, Appendix, p. vi, 1825.

Lucapina crenulata Sowerby, Tryon, Struct. Syst. Conch., Vol. 2, p. 326, pl. 83, fig. 17, 1883; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 182, pl. 44, figs. 95, 96, 1890; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 337, 1903; Keep, West American Shells, p. 260, fig. 293, 1904; Revised Ed., p. 251, fig. 250, 1911.

Macrochasma crenulata Sowerby, E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919.

Megathura crenulata Sowerby, Dall, U. S. Nat. Mus., Bull. 112, p. 185, 1921; E. K. Jordan, Bull. So. Calif. Acad. Sci., Vol. 23, p. 150, 1924; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 243, 1927.

Pleistocene: Lower Quaternary at Magdalena Bay, Lower California, Mexico (Jordan); upper San Pedro series at Los Cerritos (Arnold); chiton bed at Point Firmin, Los Angeles County (Chace).

Recent: Monterey Bay, California, to Cedros Island, Lower California, Mexico (Dall, 1921).

Genus MEGATEBENNUS Pilsbry, 1890

Megatebennus Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, pp. 178, 182, 1890.

Type (by original designation[1]), *Fissurellidea bimaculata* Dall.

Edges of shell elevated at each end, blunt at the sides, in adults not crenulated. (Pilsbry.)

Lucapina Gray[2] differs in that the edges of the shell are nearly in a plane, are finely crenulated and are not elevated at the ends. For an excellent discussion of the *Fissurellidæ* the reader is referred to Pilsbry's monograph in the twelfth volume of Tryon's Manual of Conchology (Series 1).

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[1] Pilsbry, *op. cit.*, p. 182, stated: "*F. bimaculata* Dall may be considered the type." It is the only species he included in the typical section, all the others being placed in Section *Amblychilepas* Pilsbry, 1890, type (by original designation), *F. trapezina* Sowerby.

[2] Synop. Cont. Brit. Mus., p. 151, 1840, *nomen nudum;* Gray in Sowerby, Conch. Illustr., *Fissurella*, p. 4, No. 38, fig. 29, June, 1835, *Lucapina elegans;* Gray, Proc. Zool. Soc. London for 1847, p. 147, 1847; Guide Syst. Distr. Moll. Brit. Mus., p. 166, 1857, diagnosis; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, pp. 181-182, 1890; Dall, Proc. U. S. Nat. Mus., Vol. 48, p. 437, 1915; not of H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 447, 1858.

Megatebennus bimaculata (Dall)

Fissurellidea bimaculata Dall, Amer. Journ. Conch., Vol. 7, p. 132, pl. 15, fig. 7, 1871.

Fissurellidæa bimaculata Dall, Keep, West Coast Shells, p. 97, fig. 82, 1888, 1892.

Clypidella bimaculata Dall, Gabb, Geol. Surv. Calif., Palæo., Vol. 2, pp. 86, 124, 1868-9; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 235, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 339, 1903.

Megatebennus bimaculata Dall, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 183, pl. 44, fig. 94, 1890.

Megatebennus bimoculatus Dall, U. S. Nat. Mus., Bull. 112, p. 185, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 243, pl. 85, fig. 15, 1927.

Type locality: Monterey, California; Recent.

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro, "not uncommon"; "rare" in upper San Pedro series of Los Cerritos and San Pedro, Los Angeles County (Arnold).

Recent: Forrester Island, Alaska, to Cape San Lucas, Lower California, Mexico (Dall).

Genus LUCAPINELLA Pilsbry, 1890

Lucapinella Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, pp. 179, 195, December 16, 1890.

Type (by original designation), *Clypidella callomarginata* Carpenter.

Shell oblong, apex subcentral, wholly removed by a rather large oblong perforation margined within by an untruncated callus; edge of shell blunt, scarcely crenulated in adults except in front and behind; sculptured with scaly riblets; front and side margins level, posterior margin a little elevated.

Lucapinella callomarginata (Carpenter in Dall)

Clypidella callomarginata Cpr., Dall, Amer. Journ. Conch., Vol. 7, p. 133, pl. 15, fig. 8, 1871; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 235, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 340, 1903.

Lucapinella callomarginata Carpenter, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 196, pl. 44, figs. 3-5, pl. 61, figs. 1-5, 1890.

Lucapinella callomarginata (Carpenter MS.), Dall, U. S. Nat. Mus., Bull. 112, p. 185, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 244, pl. 85, fig. 16, 1927.

Pleistocene: San Pedro to San Diego (Cooper); lower San Pedro series of Deadman Island and San Pedro, "rare"; upper San Pedro series of Crawfish George's, Los Cerritos, and San Pedro (Arnold).

Recent: Bodega Bay, California, to Magdalena Bay, Lower California, Mexico (Dall, 1921).

Gabb's use of this name[1] is a *nomen nudum*, and as Gabb no doubt referred to the same shell for which Dall later furnished a description, it can hardly be considered as preoccupying the name.

Subfamily EMARGINULINAE

Apex of shell generally not removed, the anal tube occupying an anterior slit, not a sinuation; or if apex be removed, by a perforation, the hole is provided internally with a shelf or septum projecting forward and downward from behind it, or if bounded by a callus, the latter is truncated or excavated posteriorly. (Pilsbry, 1890.)

Genus DIODORA Gray, 1821

Diodora Gray, London Med. Repos., Monthly Journ. and Review, Vol. 15, p. 233, 1821; Iredale, Proc. Malac. Soc. London, Vol. 11, p. 331, 1915; Woodring, Carnegie Inst., Publ. No. 385, p. 452, 1928.

Diadora Gray, Proc. Zool. Soc. London for 1847, p. 147, 1847; and of authors.

Glyphis Carpenter, Proc. Zool. Soc. London for 1856, p. 223, footnote; Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 220, 1857; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 202, 1890; not *Glyphis* Agassiz, 1843.

Type (by monotypy[2]), *Patella apertura* Montagu, Test. Brit., p. 491, pl. 13, fig. 10, 1808.

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[1] "*Clypidella callomarginata*, Cpr.; Brit. Assn. Rept. 1866. Post-Pliocene, San Pedro. Living," Gabb, Geol. Surv. Calif., Palæo., Vol. 2, p. 86, 1868-9.

[2] Reference to Gray, 1821, and genotype is according to Woodring, 1928.

Apex in front of the middle, absorbed by the hole, the latter bounded inside by a distinct oval hole-callus, truncated behind. (Pilsbry, description of *Glyphis.*)

Woodring has pointed out that *Diodora* is the correct spelling of this generic name, dating from Gray's original use of it in 1821. The later (1847) emendation, even though more in accord with classical usage, cannot be followed under the present rules of nomenclature.

Diodora aspera (Eschscholtz in Rathke)

Fissurella aspera Eschscholtz, in Rathke, Zool. Atlas, Pt. 2, p. 21, pl. 23, fig. 5, 1833.

Glyphis aspera Eschscholtz, Carpenter, Proc. Zool. Soc. London for 1856, p. 223; Brit. Assn. Adv. Sci., Rept. for 1863, p. 651, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 241, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 214, pl. 36, figs. 28-30, 1890; Keep, West Coast Shells, p. 96, fig. 80, 1888, 1892.

Fissuridea aspera Eschscholtz, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 197, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 338, 1903; Keep, West American Shells, Revised Edition, p. 250, fig. 249, 1911.

Diadora aspera Eschscholtz, Dall, U. S. Nat. Mus., Bull. 112, p. 185, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 247, 1926; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 237, pl. 85, fig. 11, pl. 93, fig. 1, 1927.

Type locality: Sitka, Alaska; Recent.

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro, "not uncommon"; upper San Pedro series at Crawfish George's, common; also present at Deadman Island, San Pedro, and Los Cerritos (Arnold); Santa Barbara to San Pedro (Cooper); Santa Monica (Oldroyd Collection at Stanford University); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Cook's Inlet, Alaska, to Magdalena Bay, Lower California, Mexico (Dall).

Diodora lincolni (Gray, in Sowerby), *D. cratitia* (Gould, 1846), and *D. densiclathrata* (Reeve) appear to be synonyms.

The type figure of *aspera* has been reproduced by Oldroyd.

Diodora inæqualis (Sowerby)

Fissurella inæqualis Sowerby, Proc. Zool. Soc. London, Pt. 2, p. 126, March, 1835; Reeve, Conch. Icon., Vol. 6, *Fissurella*, pl. 7, fig. 50, 1849; Carpenter, Brit. Assn. Adv. Sci., Rept. for 1856, p. 184, pl. 7, figs. 4*a-n*, explanation of plate on p. 3, 1857.

? *Fissurella pica* Sowerby, Proc. Zool. Soc. London for 1834, p. 126, 1834; Reeve, *op. cit.*, pl. 7, fig. 49, 1849.

? *Fissurella mus* Reeve, Conch. Icon., Vol. 6, *Fissurella*, pl. 16, fig. 120, 1850.

Glyphis inæqualis Sowerby, Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 622, 1864; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 215, pl. 34, fig. 63, 1890.

Fissuridea inæqualis Sowerby, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 338, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 37, p. 243, 1909.

Diadora inæqualis Sowerby, Dall, U. S. Nat. Mus., Bull. 112, p. 185, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 236, 1927.

Type locality: Galapagos Islands; Recent.

Pleistocene: Upper San Pedro series of San Pedro, Deadman Island, Long Beach, and Los Cerritos (Arnold).

Recent: Santa Barbara, California, to Mantua, Ecuador, and the Galapagos Islands (Dall, 1921).

Diodora murina (Carpenter in Dall in Orcutt)

Fissurella (Glyphis) murina Carpenter, Dall, in Orcutt, Proc. U. S. Nat. Mus., Vol. 8, p. 543, 1885.

Fissuridea murina (Carpenter) Dall, in Williamson, Proc. U. S. Nat. Mus., Vol. 15, pp. 197-199, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 339, 1903.

Fissuridea murina Carpenter, Arnold, Proc. U. S. Nat. Mus., Vol. 32, p. 545, pl. 50, figs. 3, 3*a*, 1907; U. S. Geol. Surv., Bull. 309, pl. 40, figs. 3, 3*a*, 1907.

Diadora murina (Carpenter MS.), Dall, U. S. Nat. Mus., Bull. 112, p. 185, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 237, 1927.

Type locality: Catalina Island, *fide* Oldroyd; originally reported at San Diego.

Pliocene: Third Street tunnel, Los Angeles (Arnold, 1907).

Pleistocene: Lower and upper San Pedro series of the San Pedro region (Arnold).

Recent: Crescent City, California, to Magdalena Bay, Lower California, Mexico (Dall).

Diodora subelliptica (Nomland)

Fissuridea subelliptica Nomland, Univ. Calif. Publ. Geol., Vol. 9, p. 205, pl. 10, figs. *5a*, *5b*, February 24, 1916; Vol. 10, p. 221, 1917.

Pliocene: Rare and restricted to the *Turritella nova* zone of the lower Pliocene of the Coalinga district (Nomland).

Diodora unica (Nomland)

Fissuridea unica Nomland, Univ. Calif. Publ. Geol., Vol. 10, p. 234, pl. 11, figs. 3, *3a*, *3b*, April 19, 1917.

Pliocene: In the upper Etchegoin, *Pecten coalingensis* zone, Coalinga district (Nomland).

Genus PUNCTURELLA Lowe, 1827

Puncturella Lowe, Zool. Journ., Vol. 3, p. 78, January, 1827; Forbes and Hanley, Hist. Brit. Moll., Vol. 2, p. 473, 1853; Dall, Bull. Mus. Comp. Zool., Harvard Coll., Vol. 9, p. 74, 1881; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 228, 1890; Woodring, Carnegie Inst., Publ. No. 385, p. 454, 1928.

Sipho Brown, Illust. Conch. Gt. Brit. Ire., pl. 36, figs. 14-16, November, 1827, not *Sipho* Fabricius nor Mörch.

Cemaria (Leach) Swainson, Treat. Malac., p. 243, 1840, (? not *Cemoria* (Leach) Lowe, Zool. Journ., Vol. 3, p. 76, 1827, nor Risso, 1826).

Diadora of some authors, not *Diodora* Gray, 1821.

Rimula of some authors, not of Risso, 1826.

Type (by original designation), *Patella noachina* Linnæus, figured by Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 229, pl. 27, figs. 69, 70, 1890, circumboreal, north Atlantic, also cold austral seas (*fide* Pilsbry).

Shell small, conical, apex spirally recurved, persistent or absorbed in adult stage; fissure lanceolate or oval, at front of or at summit of cone, provided within with a deck or shelly plate extending forward.

In the typical section of *Puncturella* the apex is not absorbed by the perforation. In Section *Fissurisepta* Sequenza[1] the apex is absorbed by the anal perforation. In section *Cranopsis* Adams,[2] the fissure is on the front slope instead of at the summit.

Puncturella galeata (Gould)

Rimula galeata Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 159, 1846; Rept. U. S. Expl. Exped., Vol. 12, p. 369, 1852, Atlas Moll., pl. 31, figs. 476, 477, 1856.

Puncturella noachina Linné, var. *galeata* Gould, Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 230, pl. 42, figs. 62-65, 1890.

Puncturella galeata Gould, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 341, 1903; Dall, Nautilus, Vol. 28, p. 64, 1914; U. S. Nat. Mus., Bull. 112, p. 185, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 240, pl. 93, fig. 3, 1927.

Type locality: Puget Sound, Recent.

Pleistocene: "Pliocene" [= Timms Point zone] of Deadman Island; lower San Pedro series of San Pedro, Los Angeles County, "one specimen" (Arnold).

Recent: Unalaska, Aleutian Islands, south to Santa Rosa Island, California (Dall, 1921).

This species has two conical pits on each side of the septum within the apex of the shell. This unique character distinguishes it from the other Pacific coast species.

Puncturella cucullata (Gould)

Rimula galeata Gould, Proc. Boston Soc. Nat. Hist., Vol. 2, p. 159, 1846; Rept. U. S. Expl. Exped., Vol. 12, p. 369, 1852, Atlas Moll., pl. 31, fig. 475, 1856.

Puncturella cucullata Gould, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 261, 1888; Pilsbry, Tryon's Man. Conch., Ser. 1, Vol. 12, p. 232, pl. 42, figs. 72-75, pl. 63, figs. 38-39, 1890; Dall, Nautilus, Vol. 28, p. 63, 1914; U. S. Nat. Mus., Bull. 112, p. 185, 1921; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, p. 241, pl. 93, fig. 4, 1927.

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[1] Annali del'Accademia degli Aspiranti Naturalisti, Napoli, Ser. 3, Vol. 2, p. 83, 1863; type, *Fissurisepta papillosa* Sequenza, Sicilian Miocene, designated by Woodring, *op. cit.*, p. 454, 1928. Reference taken from Woodring.

[2] Ann. Mag. Nat. Hist., Ser. 3, Vol. 5, p. 302, 1860; monotype, *C. pelex* A. Adams, Straits of Korea.

Type locality: Puget Sound; Recent.

Pliocene: Packard's Hill, Santa Barbara (Arnold).
Pleistocene: "Pliocene" of Deadman Island; lower and upper San Pedro series of San Pedro, Los Angeles County (Arnold).
Recent: Kodiak Island, Alaska, to La Paz, Lower California, Mexico (Dall, 1921).

Puncturella cucullata (Gould) has sixteen prominent, widely separated, primary radiating ribs with subdued secondary ribs between. In *Puncturella multistriata* Dall the middle one of these secondary ribs is emphasized, giving the sculptural aspect of the shell a very different appearance. In *Puncturella major* Dall these middle secondary ribs are as strong as the primaries, giving the shell twice as many primary radiating ribs as *cucullata*. Mr. George Willett, of the Los Angeles Museum staff, has a series of Recent specimens of these species but they do not appear to intergrade and he is of the opinion that they are distinct species, at least in the Recent fauna.

Puncturella cucullata attains a larger size in Alaskan waters than it does in southern California. Mr. Willett has Alaskan specimens that measure over 30 mm. in longer basal diameter whereas Catalina Island individuals rarely measure over 18 or 20 mm. In the north it occurs on rocks at the low tide line but in southern California it is obtained only by dredging.

Puncturella delosi Arnold

Puncturella delosi Arnold, Smithsonian Misc. Coll., Vol. 50, Pt. 4, p. 21, pl. 57, figs. *5a*, *5b*, 1907.

Type specimen: In the U. S. National Museum, No. 165,234.

Type locality: Bath-house Beach, Santa Barbara; uppermost Pliocene.

Pliocene: At the type locality (Arnold).

This is a small very distinct species, measuring 1.8 mm. in altitude. It has numerous, prominent, closely spaced ribs.

Puncturella cooperi Carpenter, a common dredged shell of southern California, does not seem to have been reported as a fossil. It probably occurs in the Pleistocene but may have been misidentified as one of the other species.

Superfamily PTENOGLOSSA

Family EPITONIIDAE

Genus EPITONIUM Bolten, 1798

Scala Humphreys, Mus. Calonnianum, p. 23, 1797, declared invalid by the International Commission on Zoological Nomenclature.

Epitonium Bolten, Mus. Boltenianum, Pt. 2, p. 91, 1798; Suter, Man. New Zealand Moll., p. 319, 1913; Dall, Proc. U. S. Nat. Mus., Vol. 53, p. 471, 1917; Woodring, Carnegie Inst., Publ. No. 385, p. 394, 1928.

Cyclostoma Lamarck, Mém. Soc. Hist. Nat. Paris, Vol. 1, p. 74, 1799, monotype *Turbo scalaris* Linnæus.

Scalaria Lamarck, Syst. Anim. s. Vert., p. 88, 1801, type (by monotypy), *Scalaria conica* Lamarck = *Turbo scalaris* Linnæus.

Type (by subsequent designation, Suter, 1913), *Turbo scalaris* Linnæus (+ *Scalaria pretiosa* Lamarck), figured by Tryon, Man. Conch., Ser. 1, Vol. 9, p. 54, pl. 11, fig. 31, 1887, Indo-Pacific; Recent.

The typical subgenus of *Epitonium* embraces the species with rapidly enlarging and loosely coiled whorls, with a detached peristome and rather widely spaced, varix-like axial ribs.

Practically no attempt has been made by the present writers to revise the subgenera or species of *Epitonium*.

Subgenus **OPALIA** H. and A. Adams, 1853

Opalia H. and A. Adams, Gen. Rec. Moll., Vol. 1, p. 223, November, 1853; de Boury, Monog. Scalidæ Viv. Fos., Pt. 1, p. xxvi, 1886; Journ. de Conchyl., Vol. 57, p. 256, 1909; Cossmann, Ess. Paléo. Comp., Vol. 9, p. 77, 1912.

Type (by subsequent designation, de Boury, 1886), *Opalia australis* (Lamarck), figured by Tryon, Man. Conch., Ser. 1, Vol. 9, p. 76, pl. 16, fig. 90, 1887, Australia; Recent.

The species of the subgenus *Opalia* are higher spired and more tightly coiled than those belonging to the typical subgenus of *Epitonium.* They also possess a basal carina. The type, *E. australe*, is remarkably similar to *E. wroblewskyi* (Mörch).

Epitonium (Opalia) wroblewskyi (Mörch)

Scalaria borealis Gould, Rept. U. S. Expl. Exped., Vol. 12, p. 207, 1852; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 76, pl. 16, fig. 89, 1887; not of Beck in Lyell, Rising of Sweden, p. 37, pl. 2, figs. 11, 12, 1839.

Scala wroblewskyi Mörch, Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 8, p. 190, 1876.

Opalia borealis Gould, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 255, 1888; Keep, West Coast Shells, p. 49, fig. 30, 1888, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 266, 1903.

Epitonium (Opalia) borealis Gould, Berry, Nautilus, Vol. 22, p. 38, 1908.

? Epitonium borealis Gould, Clark, Univ. Calif. Publ. Geol., Vol. 8, p. 422, 1915.

Epitonium (Opalia) wroblewskii Mörch, Dall, U. S. Nat. Mus., Bull. 112, p. 113, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 51, pl. 31, fig. 5, 1927.

Shell large, high spired, with few, low, sometimes very indistinct varices, the peristome coalescing with the parietal wall.

Type specimen: In the British Museum (Natural History).

Type locality: Vancouver Island, British Columbia; Recent.

? Miocene: Lower San Pablo formation, upper Miocene of middle California ? (Clark).

Pliocene: Excavation at Fifth and Hope Streets, Los Angeles (coll. by Charles M. Jay); Bath-house Beach, Santa Barbara, uppermost Pliocene (Berry).

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, "not rare" (T. S. Oldroyd); upper San Pedro series of San Pedro, "two specimens" (Arnold).

Recent: Forrester Island, Alaska, to San Diego, California (Dall).

This species is thinner shelled and slenderer than *Epitonium varicostatum* (Stearns) and its variety *anomalum* of the middle Pliocene of Southern California. Mature individuals attain a length of 50 mm. or more, but the two specimens from the Fifth and Hope Streets deposit, Los Angeles (lower part of the upper Pliocene), are small and apparently immature. These latter show no signs of intergradation with *varicostatum.* Recent specimens of *wroblewskyi* often lack axial ribs on the body and penultimate whorls of adult individuals, but we have not seen any specimens with the axial sculpture entirely obsolete, analogous to variety *anomalum* of the mid-Pliocene species. Both *Epitonium wroblewskyi* and *E. varicostatum* have occasional crudely developed varices independent of the axial sculpture.

Epitonium (Opalia) varicostatum (Stearns)

Plate 24, Figure 20

Opalia varicostata Stearns, Proc. Acad. Nat. Sci. Phila. for 1875, p. 463, pl. 27, figs. 2-5, 1875; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 255, 1888; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 245, 1892; Stearns, Proc. U. S. Nat. Mus., Vol. 21, p. 298, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 267, 1903; Proc. U. S. Nat. Mus., Vol. 32, p. 527, 1907; Dall, Vol. 53, p. 473, 1917.

Type specimen: In the U. S. National Museum.

Type locality: Pacific Beach, San Diego; Pliocene.

Pliocene: Middle Pliocene of Pacific Beach (Stearns) and of the old San Diego well in Balboa Park (Cooper), San Diego; Temescal Canyon, near Santa Monica (Arnold, 1907), middle Pliocene.

Epitonium varicostatum (Stearns) is a large, heavy-shelled species with typically ten or eleven varix-like ribs. It occurs, so far as known, only in the middle Pliocene of southern California, and seems to be characteristic of the San Diego horizon. At Pacific Beach, San Diego, it grades into variety *anomalum* (Stearns) through gradual obsolescence of the axial ribs. It is heavier and relatively shorter spired than *Epitonium wroblewskyi* (Mörch), with which it does not appear to intergrade.

Epitonium (**Opalia**) **varicostatum** (Stearns) variety **anomalum** (Stearns)

Opalia anomala Stearns, Proc. Acad. Nat. Sci. Phila. for 1875, p. 464, pl. 27, fig. 1, 1875; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 255, 1888; Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 245, 1892; Stearns, Proc. U. S. Nat. Mus., Vol. 21, p. 298, 1898; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 266, 1903; Dall, Proc. U. S. Nat. Mus., Vol. 53, p. 473, 1917.

Type specimen: In the U. S. National Museum.

Type locality: Pacific Beach, San Diego; Pliocene.

Pliocene: San Diego well (Cooper); Pacific Beach, San Diego (Stearns).

The variety *anomalum* (Stearns) lacks the axial ribs of the typical form of *varicostatum,* except on the upper whorls of the spire where axial sculpture is often present. Intergradation occurs with the typical form at Pacific Beach, San Diego. As a variety, it is of little value.

Epitonium (**Opalia**) **rugiferum** (Dall)

Opalia rugifera Dall, Nautilus, Vol. 22, p. 80, 1908.
Epitonium (*Opalia*) *rugiferum* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 52, pl. 3, fig. 10, April 2, 1909.

Type specimen: In the U. S. National Museum.

Type locality: Low Pass Canyon, Alaska Peninsula; "Miocene" (= Pliocene ?).

? Miocene: Low Pass Canyon, Alaska Peninsula (Dall, 1908).
? Pliocene: Rock Creek, Columbia County, Oregon (Dall, 1909).

This is a more evenly ribbed, shorter spired shell than *E. varicostatum,* which it otherwise closely resembles. The Rock Creek locality referred to above may be Miocene or even Oligocene in age.

Epitonium (*Opalia*) *tremperi* (Bartsch)[1] from San Clemente Island, California, is a small species with numerous axial riblets and definite spiral threads quite unlike the species listed above.

Subgenus **STHENORYTIS** Conrad, 1868

Sthenorytis Conrad, Amer. Journ. Conch., Vol. 3, p. 259, April 2, 1868.

Type (by monotypy), *S. pachypleura* Conrad, Journ. Acad. Nat. Sci. Phila., Ser. 2, Vol. 8, p. 565, 1862, figured in Amer. Journ. Conch., Vol. 3, pl. 21, fig. 4, 1868; Calvert Cliffs, Maryland; Miocene.

Shell short with relatively very large body whorl; axial ribs thick, prominent, acuminate at summit; aperture nearly round, with a thickened margin.

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[1] Proc. U. S. Nat. Mus., Vol. 70, Art. 11, p. 3, pl. 1, fig. 8, 1927.

Epitonium (Sthenorytis) stearnsii (Dall)

Scala (*Sthenorytis*) *stearnsii* Dall, Trans. Wagner Inst. Sci., Vol. 3, p. 245, pl. 21, fig. 4, December, 1892.
Scala stearnsii Dall, Stearns, Proc. U. S. Nat. Mus., Vol. 21, p. 298, 1898.

Type specimen: In the U. S. National Museum, No. 106,904.

Type locality: Pacific Beach, San Diego; Pliocene.

Pliocene: Middle Pliocene of Pacific Beach, San Diego (Dall).

This is a short, stout species, with strong axial ribs which taper posteriorly.

Hanna and Hertlein[1] have reported *Epitonium* (*Sthenorytis*) *toroense* (Dall) from the Pliocene beds of Monserrate Island, Gulf of California, Mexico, but this species is unknown in the Recent or fossil faunas of California.

Subgenus **DENTISCALA** de Boury, 1886

Epitonium (Dentiscala) insculptum (Carpenter)

Opalia (*? crenatoides*, var.) *insculpta* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 660, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 17, p. 277, April, 1866.
Opalia crenatoides var. (?) *insculpta* Carpenter, Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 255, 1888.
Opalia crenatoides Carpenter, var. *insculpta* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 267, 1903.
Dentiscala insculpta Carpenter, Dall, Proc. U. S. Nat. Mus., Vol. 53, p. 473, 1917; Van Winkle, Bull. Amer. Paleontology, Vol. 8, p. 350 (or Bull. No. 36, p. 4), pl. 1, figs. 10, 11, 1921.

Type specimens: In the collection at Cornell University (Van Winkle).

Type locality: Near Santa Barbara; (Pliocene or) Pleistocene.

Upper Pliocene: At the type locality (?).
Pleistocene: Santa Barbara (Carpenter; Cooper); upper San Pedro series at Deadman Island, "rare" (Arnold).

Epitonium insculptum (Carpenter) has thirteen to sixteen axial ribs and no spiral striæ. Mr. A. M. Strong, who has made a careful study of the Pacific coast *Epitoniidæ*, says that the delicate spiral sculpture of such species as *crenimarginatum* would no doubt be lost during fossilization and that this factor must be considered in order to avoid redescribing living species in the fossil state.

E. crenatoides is a Recent species with fewer varices than *insculptum* and appears to be quite distinct, though no doubt related.

Subgenus **NODISCALA** de Boury, 1890

Nodiscala de Boury, Bull. Soc. Malac. Ital., Vol. 14, p. 12, 1890; Woodring, Carnegie Inst., Publ. No. 385, p. 404, 1928.

Type (by original designation) *Nodiscala bicarinata* (Sowerby), figured by Tryon, Man. Conch., Ser. 1, Vol. 9, p. 82, pl. 17, fig. 28, 1887, Philippines; Recent.

Shell small, slender, suture serrate; basal disk poorly developed; peristome complete, thick; sculpture consisting of obscure axial ribs and of spiral grooves; body whorl with two heavy spiral ridges, the lower one of which seems to limit the basal disk. (After Woodring.)

Epitonium (Nodiscala) retiporosum (Carpenter)

Opalia retiporosa Carpenter, Proc. Calif. Acad. Sci., Vol. 3, p. 222, 1864; Brit. Assn. Adv. Sci., Rept. for 1863, p. 660, 1864.
Epitonium (*Opalia*) *retiporosa* Carpenter, Moody, Univ. Calif. Publ. Geol., Vol. 10, p. 43, 1916.
Nodiscala retiporosa Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 114, 1921.
Epitonium (*Nodiscala*) *retiporosum* Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 54, 1927.

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[1] Proc. Calif. Acad. Sci., Ser. 4, Vol. 16, p. 143, 1927.

Type specimen: In the California State Collection, No. 1,014, (University of California ?).

Type locality: Catalina Island, California, in 40 fathoms.

Pliocene: Excavation at Fourth Street between Hill and Broadway, Los Angeles, "rare" (Moody).
Recent: Catalina Island, California, to the Gulf of California, Mexico (Dall, 1921).

This species is not well known and it is difficult to recognize it from Carpenter's description. It was not figured by Carpenter nor by Tryon.

Subgenus **BOREOSCALA** Kobelt, 1902

Shell usually white, with a basal disk bounded by a keel and both spiral and axial sculpture distinct.

Arctoscala Dall, 1908,[1] and *Liroscala* de Boury, 1909, are synonyms. The type of the subgenus is *Epitonium greenlandicum* (Perry).

Epitonium (Boreoscala) condoni Dall

Arctoscala condoni Dall, Nautilus, Vol. 22, p. 80, 1908, *nomen nudum* with locality.
Epitonium (Boreoscala) condoni Dall, U. S. Geol. Surv., Prof. Paper 59, p. 53, pl. 3, figs. 1, 12, 1909.

Type specimen: In the U. S. National Museum.

Type locality: Eugene, Oregon; Oligocene.

Oligocene: Eugene, Oregon, and Rock Creek, Columbia County, Oregon (Dall, 1909, as Miocene).
Miocene: Low Pass, Alaska Peninsula (Dall, 1922).

Epitonium (Boreoscala) greenlandicum (Perry)

Scalaria greenlandica Perry, Conch., pl. 28, fig. 8, 1811.
? *Scalaria groenlandica* Chemnitz, Tryon, Man. Conch., Ser. 1, Vol. 9, p. 76, pl. 16, fig. 91, 1887.
Epitonium (Boreoscala) greenlandicum Perry, Dall, Proc. U. S. Nat. Mus., Vol. 53, p. 472, 1917; Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 55, 1927.
Boreoscala greenlandica Perry, Dall, Journ. Washington Acad. Sci., Vol. 9, p. 2, 1919; U. S. Nat. Mus., Bull. 112, p. 114, 1921.

Type locality: Greenland; Recent.

Pliocene: Upper Pliocene of St. George Island, Pribilof Islands (Dall, 1919).
Pleistocene: Pleistocene terraces of Japan (Dall, 1917).
Recent: Arctic Ocean near Point Barrow and southward on the west to northern Japan and on the east to Wrangell, Alaska; circumboreal (Dall, 1921).

Epitonium (Boreoscala) hemphilli (Dall)

Scala hemphilli Dall, Proc. U. S. Nat. Mus., Vol. 1, p. 16, 1878; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 263, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 264, 1903.
Epitonium hemphilli Dall, Proc. U. S. Nat. Mus., Vol. 53, p. 472, 1917.

Pliocene: San Diego well, Balboa Park, San Diego (Dall, 1878).
Pleistocene: Upper San Pedro series of San Pedro, "one immature specimen" (Arnold).

Subgenus **ASPERISCALA** de Boury, 1909

Asperiscala de Boury, Journ. de Conchyl., Vol. 57, p. 258, 1909.

Type (by original designation), *Scalaria bellastriata* Carpenter, California; Recent.

Shell without basal disk or carina; spiral sculpture present, axial lamellæ somewhat spiny or angular at the shoulder.

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[1] Nautilus, Vol. 22, p. 80, December, 1908, *type*, by original designation, *A. greenlandica* (Perry).

Epitonium (Asperiscala) bellastriatum (Carpenter)

Scalaria bellastriata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 660, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 221, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 263, 1888.
Scala bellastriata Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 263, pl. 9, fig. 17, 1903.
Asperoscala bellastriata Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 114, 1921.
Epitonium (*Asperoscala*) *bellastriatum* Carpenter, Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 55, 1927.

Type specimen: In the California State Collection, No. 393*b*, (at the University of California ?).

Type locality: Monterey, California; Recent.

Pleistocene: Santa Barbara (Cooper); upper San Pedro series of San Pedro, "four" (Arnold); upper Pleistocene, of Santa Monica (Oldroyd Collection at Stanford University).
Recent: Monterey to San Diego, California (Dall, 1921).

Epitonium (Asperiscala) cedrosense Jordan and Hertlein

Epitonium cedrosensis E. K. Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 446, pl. 3, fig. 3, July 22, 1926.

Type specimen: At the California Academy of Sciences, No. 2,116.

Type locality: Bernstein's Abalone camp, Cedros Island, Lower California, Mexico; Pliocene.

Pliocene: Cedros Island and Turtle Bay, Lower California, Mexico (Jordan and Hertlein).

Epitonium (Asperiscala) clarki T. S. Oldroyd

Epitonium clarki T. S. Oldroyd, Nautilus, Vol. 34, p. 115, pl. 5, fig. 13, April, 1921.

Type locality: Santa Monica, Los Angeles County; Pleistocene.

Pleistocene: Upper Pleistocene of Santa Monica (T. S. Oldroyd).

E. clarki Oldroyd is more slender than *bellastriatum* (Carpenter) and is apparently a distinct species.

Epitonium (Asperiscala) dallasi E. K. Jordan and Hertlein

Epitonium dallasi E. K. Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 447, pl. 30, fig. 2, July 22, 1926.

Type specimen: At the California Academy of Sciences, No. 2,122.

Type locality: One mile southeast of Turtle Bay, Lower California, Mexico; Pliocene.

Pliocene: At the type locality (Jordan and Hertlein).

Subgenus **NITIDISCALA** de Boury, 1909

Nitidiscala de Boury, Journ. de Conchyl., Vol. 57, p. 257, 1909; Woodring, Carnegie Inst., Publ. No. 385, p. 400, 1928.
"*Nitidoscala*" de Boury, of Dall, 1921, and other authors.

Type (by original designation), *Scalaria unifasciata* Sowerby, Thes. Conch., Vol. 1, *Scalaria*, p. 98, pl. 33, fig. 68, *ante* April 11, 1844, also figured in Tryon, Man. Conch., Vol. 9, p. 71, pl. 14, fig. 55, 1887; West Indies; Recent.

Shell small, rather slender, turreted, without a basal disk; axial sculpture consisting of strongly reflected retractive axial ribs fused across the sutures; spiral sculpture absent.

Epitonium (Nitidiscala) acrostephanum Dall

Epitonium (Crisposcala) acrostephanum Dall, Proc. U. S. Nat. Mus., Vol. 34, p. 251, June 16, 1908.
Nitidoscala acrostephanus Dall, U. S. Nat. Mus., Bull. 112, p. 116, 1921.
Epitonium (Nitidoscala) acrostephanum Dall, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 65, 1927.
Epitonium acrostephanum Dall, Jordan, Proc. Calif. Acad. Sci., Ser. 4, p. 245, 1926.

Type specimen: In the U. S. National Museum, No. 110,638.

Type locality: Monterey, California; Recent.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County, "one specimen" (T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

This species is very close to *Epitonium tabulatum* (Dall), but the latter is a relatively broader shell.

Epitonium (Nitidiscala) caamanoi (Dall and Bartsch)

Scala caamanoi Dall and Bartsch, Canadian Geological Surv., Memoir 14N, p. 13, pl. 1, fig. 1, 1910.
Nitidoscala caamanoi Dall and Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 116, 1921.
Epitonium (Nitidoscala) caamanoi Dall and Bartsch, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 62, pl. 31, fig. 3, 1927.

Type specimen: In the Geological Survey Museum at Ottawa ?

Type locality: Barkley Sound, Vancouver Island, British Columbia; Recent.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, Los Angeles County, "four specimens" (T. S. Oldroyd). *Recent:* Vancouver Island, British Columbia, to San Pedro, California (Dall, 1921).

Epitonium (Nitidiscala) continuatum T. S. Oldroyd

Epitonium (Nitidoscala) continuatum T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, pp. 13, 35, pl. 2, fig. 10, January, 1925.

Type specimen: In the U. S. National Museum, No. 352,383.

Type locality: Nob Hill cut, San Pedro; Pleistocene.

Pleistocene: At the type locality, "one specimen" (Oldroyd).

Epitonium (? Nitidiscala) contrerasi E. K. Jordan and Hertlein

Epitonium contrerasi E. K. Jordan and Hertlein, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 446, pl. 30, fig. 4, 1926.

Type specimen: At the California Academy of Sciences, No. 2,121.

Type locality: One mile southeast of Turtle Bay, Lower California, Mexico; Pliocene.

Pliocene: At the type locality (Jordan and Hertlein).

Epitonium (Nitidiscala) crebricostatum (Carpenter)

Scalaria crebricostata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 660, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 222, 1864; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 263, 1888.
Scala crebricostata Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 263, 1903.
Nitidoscala crebricostata Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 115, 1921.
Epitonium (Nitidoscala) crebricostatum Carpenter, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 61, 1927.

Type specimen: In the California State Collection, No. 393, (at the University of California ?).

Type locality: Monterey, California; Recent.

Pleistocene: Santa Barbara and San Pedro (Cooper); lower San Pedro series at San Pedro, also at Barlow's Ranch and the old irrigation ditch near Ventura; foot of Twenty-sixth Street, San Diego; upper San Pedro series at San Pedro and Deadman Island, Los Angeles County (Arnold); Nob Hill cut, San Pedro (T. S. Oldroyd).

Recent: Vancouver Island, British Columbia, to the Gulf of California, Mexico (Dall, 1921).

Epitonium (Nitidiscala) indianorum (Carpenter)

Scalaria indianorum Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 660, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 31, January, 1865; Tryon, Man. Conch., Ser. 1, Vol. 9, p. 70, pl. 14, fig. 48, 1887; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 263, 1888.

Scala indianorum Carpenter, Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 210, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 264, pl. 5, fig. 4, 1903.

Nitidoscala indianorum Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 115, 1921.

Epitonium indianorum Carpenter, I. S. Oldroyd, Univ. Washington, Publ. Puget Sound Biol. Sta., Vol. 4, p. 107, 1924.

Epitonium (*Nitidoscala*) *indianorum* Carpenter, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 57, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Epitonium (*Nitidiscala*) *indianorum* (Carpenter), Strong, Trans. San Diego Soc. Nat. Hist., Vol. 6, p. 192, pl. 20, figs. 1, 2*a*, 2*b*, 1930.

Type specimen: In the U. S. National Museum, No. 15,521.

Type locality: Neah Bay, Washington; Recent.

Pliocene: "Pico formation," near Ventura (Waterfall).

Pleistocene: "Pliocene" of Deadman Island (Timms Point zone), lower Pleistocene; common in the lower and upper San Pedro series of San Pedro and vicinity (Arnold); lower San Pedro series of Nob Hill cut, San Pedro, "not rare" (T. S. Oldroyd); "Saugus formation," near Ventura (Waterfall).

Recent: Forrester Island, Alaska, to Todos Santos Bay, Lower California, Mexico (Dall, 1921).

This species has been confused with others. A. M. Strong, conchologist of Los Angeles, has made a critical study of California Recent Epitoniums, particularly *Epitonium indianorum* and its allies, and his results, part of which have just been published, clear up much of the confusion which has obscured the identity of some of the species herein catalogued.

Epitonium (Nitidiscala) tinctum (Carpenter)

Scalaria ? var. *tincta* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 660, 1864.

Scalaria (*? indianorum*, var.) *tincta* Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 31, January, 1865.

Scalaria subcoronata Carpenter, Proc. Calif. Acad. Sci., Vol. 3, p. 221, 1866; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 263, 1888.

"*Scala hindsii* Carpenter," Williamson, Proc. U. S. Nat. Mus., Vol. 15, p. 209, 1892; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 264, 1903; Keep, West Coast Shells, p. 183, fig. 174, 1911, not of Carpenter, 1856, a Panama species.

Not "*Scala tincta* Carpenter," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 265, pl. 5, fig. 3, 1903.

Epitonium (*Nitidoscala*) *fallaciosum* Dall, Proc. U. S. Nat. Mus., Vol. 53, p. 478, 1917; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 59, 1927.

Nitidoscala subcoronata Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 115, 1921.

Nitidoscala tincta Carpenter, Dall, *op. cit.*, p. 115, 1921.

Nitidoscala fallaciosa Dall, *op. cit.*, p. 115, 1921.

Epitonium (*Nitidoscala*) *tinctum* Carpenter, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 58, 1927.

Epitonium fallaciosum Dall, E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Epitonium tinctum Carpenter, E. K. Jordan, *op. cit.*, p. 245, 1926.

Epitonium (*Nitidoscala*) *subcoronatum* Carpenter, I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 58, 1927.

Epitonium (*Nitidiscala*) *tinctum* (Carpenter), Strong, Trans. San Diego Soc. Nat. Hist., Vol. 6, p. 193, pl. 20, figs. 3, 4, 5*a*, 5*b*, 1930.

Type specimens: Of *tinctum*, in the U. S. National Museum, see discussion by Strong, 1930; of *subcoronatum*, sometimes assumed to be in the California State Collection, University of California, specimen No. 393*a*, probably in the U. S. National Museum, No. 13,830*b*, see discussion by Strong, 1930; of *fallaciosum*, in the U. S. National Museum.

Type localities: Of *tinctum*, San Pedro, California, Recent; of *subcoronatum*, Monterey, California, Recent; of *fallaciosum*, California, Recent.

Pliocene: San Diego well, Balboa Park, San Diego, middle Pliocene (Cooper, as *subcoronata*, probably also his record under *tinctum*).

Pleistocene: Lower San Pedro series of Deadman Island and San Pedro (Arnold) as *fallaciosum* and *crebricostatum*); lower San Pedro series of Nob Hill cut, San Pedro (T. S. Oldroyd, as *subcarinatum* and *tinctum*); Santa Barbara and San Pedro (Cooper, as *subcoronatum*, the Santa Barbara record possibly referring to the Santa Barbara horizon, upper Pliocene); Barlow's Ranch near Ventura (Arnold); upper San Pedro series of Deadman Island and San Pedro; Pacific Beach and foot of Twenty-sixth Street, San Diego (Arnold); upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan), as *fallaciosum* and *tinctum*).

Recent: Vancouver Island, British Columbia, south to Lower California, probably to the Gulf of California.

According to Strong (1930) *E. tinctum* differs from *E. indianorum* principally in its smaller size, more robust form, and the presence of the color band.

Epitonium (Nitidiscala) cooperi Strong

"*Scala tincta* Carpenter," Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 265, pl. 5, fig. 3, 1903, not of Carpenter, 1864.

"*Epitonium hindsii* Carpenter," Packard, Univ. Calif. Publ. Zool., Vol. 14, p. 319, pl. 36, figs. 14*a*, 14*b*, 1918.

"*Epitonium fallaciosum* Dall," Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926.

Epitonium (*Nitidiscala*) *cooperi* Strong, Trans. San Diego Soc. Nat. Hist., Vol. 6, pp. 189, 194, pl. 20, figs. 6*a*, 6*b*, 7, 8*a*, 8*b*, 1930.

Type specimen: In the collection of the San Diego Society of Natural History, No. 345. (Paratypes in the U. S. National Museum, Nos. 46,222 and 56,052.)

Type locality: San Pedro, California; Recent.

? Pliocene: Pacific Beach and Russ School, San Diego (Arnold).

Pleistocene: Barlow's Ranch, Ventura (Arnold), = Las Posas zone; rare in the lower San Pedro of San Pedro and vicinity; common in the upper San Pedro of San Pedro and vicinity, also at Pacific Beach and Twenty-sixth Street, San Diego (Arnold); Pleistocene, San Quintin Bay, Lower California (Jordan).

Recent: San Francisco Bay, California (Packard in Strong), to the Gulf of California (?).

This species has been well described and figured by Strong.

Subgenus **ACRILLA** H. Adams, 1860

Acrilla H. Adams, Proc. Zool. Soc. London, Vol. 28, p. 241, 1860.

Type (by original designation), *Scalaria acuminata* Sowerby, figured by Tryon, Man. Conch., Ser. 1, Vol. 9, p. 83, pl. 17, figs. 30, 35, 1887, Indo-Pacific; Recent.

Shell high spired, turritelliform, imperforate, with many whorls which are sculptured with numerous filiform ribs and a spiral ridge which subcarinates the last whorl and may be slightly visible at the sutures; aperture oval, outer lip thin.

Epitonium (Acrilla) atwoodi Dall

Epitonium (*Acrilla*) *atwoodi* Dall, Nautilus, Vol. 22, pp. 80, 81, 1908.

Type specimen: In the U. S. National Museum, No. 111,072.

Type locality: About five miles south of the head of Port Moller, in the pass leading across Alaska Peninsula called Low Pass Canyon; Miocene.

Miocene: At the type locality (Dall).

Subgenus **CATENOSCALA** Dall, 1908

Catenoscala Dall, Nautilus, Vol. 22, p. 80, December, 1908; U. S. Geol. Surv., Prof. Paper 59, p. 53, April 2, 1909.

Type (by monotypy), *Catenoscala oregonensis* Dall, Eugene, Oregon, stated to be of Miocene age, probably middle Oligocene.

Shell resembling that of *Boreoscala* but with the anterior portion of each whorl covered by a thick layer of enamel which obscures both axial and spiral sculpture.

Epitonium (Catenoscala) oregonense Dall

Catenoscala oregonensis Dall, Nautilus, Vol. 22, p. 80, December, 1908, *nomen nudum*, with locality.
Epitonium (*Catenoscala*) *oregonense* Dall, U. S. Geol. Surv., Prof. Paper 59, p. 54, pl. 3, fig. 3, April 2, 1909.

Type specimen: In the U. S. National Museum.

Type locality: Eugene, Oregon, as Miocene, probably middle Oligocene.

Oligocene: Eugene, Oregon, probably middle Oligocene; east side of Scow Bay, southeast of Port Townsend, Washington; near the west side of Oak Bay, Puget Sound (Dall, 1909, as Miocene, but probably all Oligocene); Low Pass Canyon, Alaska Peninsula (Dall, 1908, as Miocene, but probably of Oligocene age).

Superfamily Gymnoglossa

Family MELANELLIDAE

As the west American *Melanellidæ* have been recently monographed by Bartsch,[1] it is only necessary here to catalogue those species which come within the scope of the present paper. Most of the references and type designations have been taken from Bartsch. A comparison of some of the supposedly extinct Pleistocene species listed below with Recent species probably will show that all of them are conspecific with or only varietally distinct from their living representatives.

Genus **MELANELLA** Bowdich, 1822

Melanella Bowdich, Elements of Conchology, Vol. 1, p. 27, 1822; Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 302, 1907.

Type (by monotypy), *Melanella dufresnii* Bowdich, *op. cit.*, pl. 6, fig. 17, and expl. plate, 1822.

Shell small, slender, white and polished, with a straight or curved spire of flat-sided whorls; apex acute; aperture oval but produced to a point posteriorly, outer lip sometimes thickened internally, inner lip reflected over body whorl; not umbilicated; operculum horny, spiral, with nucleus eccentric, or operculum absent.

Through some oversight, Bartsch (1917) placed the Melanellas with flexed or curved spires in the subgenus *Balcis* Leach,[2] whereas the typical *Melanella* as figured by Bowdich has a distinctly curved spire. It is probable that the distinction between the curved and straight shells is of little taxonomic significance.

Section Melanella, s. s.

Melanellas with curved spires.

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[1] A Monograph of West American Melanellid Mollusks, Proc. U. S. Nat. Mus., Vol. 53, pp. 295-356, pls. 34-59, Aug. 13, 1917.

[2] Synop. Moll. Gt. Brit., p. 200, 1852, *fide* Bartsch, 1917.

Melanella draconis Bartsch

Melanella (Balcis) draconis Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 319, pl. 39, fig. 2, 1917.

Pleistocene: Deadman Island, San Pedro Harbor, Los Angeles County (Bartsch).

Melanella arnoldi Bartsch

Melanella (Balcis) arnoldi Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 322, pl. 40, fig. 8, 1917.

Pleistocene: Sand Rock, lower San Pedro series, Deadman Island, Los Angeles County (Bartsch).

Melanella thersites (Carpenter)

Eulima thersites Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 659, 1864; Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 396, 1865.

Eulima lowei Vanatta, Proc. Acad. Nat. Sci. Phila. for 1899, p. 254, pl. 11, figs. 9, 10, 1900.

Eulima bistorta Vanatta, *op. cit.*, p. 254, pl. 11, figs. 7, 8, 1900.

Melanella (Balcis) thersites Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 323, pl. 41, figs. 1, 2, 3, 1917.

Melanella thersites Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 117, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 70, pl. 47, fig. 2, 1927.

Pleistocene: Lower San Pedro series of Nob Hill cut, Los Angeles (T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey, California, to San Geronimo Island, Lower California, Mexico (Dall).

Melanella berryi Bartsch

Melanella (Balcis) berryi Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 326, pl. 42, fig. 3, 1917.

Melanella berryi Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 118, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 72, pl. 45, fig. 3, 1927.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Monterey Bay to Catalina Island, California (Dall, 1921).

Melanella lastra Bartsch

Melanella (Balcis) lastra Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 321, pl. 40, fig. 3, 1917.

Melanella lastra Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 117, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 70, pl. 42, fig. 3, 1927.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: San Pedro, California, to Magdalena Bay, Lower California (Dall, 1921).

Melanella perfalcata Bartsch

Melanella (Balcis) perfalcata Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 327, pl. 42, fig. 4, 1917.

Melanella perfalcata Bartsch, T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 13, 1925.

Pleistocene: Lower San Pedro series of Deadman Island (Bartsch); lower San Pedro series of Nob Hill cut (T. S. Oldroyd), Los Angeles County.

Melanella falcata (Carpenter)

Eulima falcata Carpenter, Proc. Zool. Soc. London for 1865, p. 280; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 268, pl. 9, fig. 15, 1903.

Melanella (Balcis) falcata Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 329, pl. 42, fig. 6, 1913.

Type specimen: In the U. S. National Museum, No. 123.

Type locality: Acapulco, Mexico; Recent.

Pleistocene: Lower San Pedro series of Deadman Island and upper San Pedro series of San Pedro, one specimen from each (Arnold).

Recent: West coast of Mexico.

Melanella loleta E. K. Jordan

Melanella loleta E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 251, pl. 25, fig. 6, 1926.

Pleistocene: Upper Pleistocene, San Quintin Bay, Lower California, Mexico (Jordan).

Section EULIMA Risso, 1826

Eulima Risso, Hist. Nat. Eur. Mérid., Vol. 4, p. 123, 1826.

Melanellas with straight spires.

Melanella micans (Carpenter)

Eulima micans Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 659, 1864; Proc. Acad. Nat. Sci. Phila. for 1865, p. 63; Cooper, 7th Ann. Rept. Calif. State Mineralogist, p. 240, 1888; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 269, pl. 9, fig. 12, 1903.

Melanella (Melanella) micans Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 303, pl. 34, figs. 1-6, 1917.

Melanella micans Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 118, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 74, 1927.

Pleistocene: Santa Barbara to San Diego (Cooper); upper and lower San Pedro series of San Pedro region; Barlow's Ranch, near Ventura; Spanish Bight, San Diego (Arnold); Santa Monica (collection of Dr. F. C. Clark); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Recent: Vancouver Island, British Columbia, to Point Abreojos, Lower California, Mexico (Dall, 1921).

The large northern specimens have been named *borealis* Bartsch.

Melanella rutila (Carpenter)

Eulima rutila Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 659, 1864; Proc. Calif. Acad. Sci., Vol. 3, p. 221, 1865.

Melanella (Melanella) rutila Carpenter, Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 306, pl. 35, figs. 2, 3, 6, 1917.

Melanella rutila Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 118, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 75, pl. 46, figs. 2, 3, 6, 1927.

Pleistocene: Deadman Island (Bartsch, as lower San Pedro series); Santa Monica, Santa Monica Canyon, San Pedro, Los Cerritos, and lumber yard at San Pedro, Los Angeles County; foot of Twenty-sixth Street, Spanish Bight, San Diego; San Quintin, Lower California, Mexico (Bartsch, as upper San Pedro series); San Quintin Bay, Lower California, Mexico (Jordan, as upper Pleistocene).

Recent: Craig, Alaska (Willett); Vancouver Island, British Columbia, to Magdalena Bay, Lower California, Mexico (Dall, 1921).

This and the preceding species are the common Melanellas of California.

Melanella monicensis Bartsch

Melanella (Melanella) monicensis Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 309, pl. 36, fig. 2, 1917.

Pleistocene: Santa Monica (Bartsch).

Melanella necropolitana Bartsch

Melanella (Melanella) necropolitana Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 309, pl. 36, fig. 3, 1917.

Pleistocene: Sand Rock, lower San Pedro series, of Deadman Island, California (Bartsch).

Melanella oldroydi Bartsch

Melanella (Melanella) oldroydi Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 309, pl. 36, figs. 5, 6, 7, 1917.

Melanella oldroydi Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 118, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 76, pl. 41, figs. 5, 6, 7, 1927.

Pleistocene: Lower San Pedro series of Deadman Island; upper San Pedro series of Santa Monica, Santa Monica Canyon, San Pedro, and lumber yard at San Pedro, Los Angeles County; Spanish Bight, San Diego; San Quintin, Lower California, Mexico (Bartsch).

Recent: San Pedro to Point Abreojos, Lower California (Dall, 1921).

Dall (1921) notes under this species: "Also Pliocene and Pleistocene."

Melanella hastata (Sowerby)

Eulima hastata Sowerby, Proc. Zool. Soc. London for 1834, p. 6, 1834; A. Adams, in Sowerby, Thes. Conch., Vol. 2, p. 794, pl. 169, figs. 7, 8, 1854; Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 268, pl. 9, fig. 9, 1903.

Melanella (Melanella) hastata Sowerby, Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 317, pl. 38, figs. 4, 6, 1917.

Pleistocene: Lower San Pedro series at Deadman Island, one specimen; Barlow's Ranch, near Ventura; upper San Pedro series at San Pedro, four specimens; Spanish Bight, San Diego (Arnold).

Recent: West coast of Mexico to Ecuador.

"*Eulima*" *smithi* Van Winkle,[1] from the *Molopophorus lincolnensis* zone on the Cowlitz River, Washington, is not a *Melanella.* The species is minute, not well figured and its generic assignment must await further study of actual specimens. The name is a homonym of "*Eulima*" *smithi* Reagan[2] and when its generic affiliation can be determined it may be necessary to rename it.[3]

"*Eulimella*" *gabbiana* Anderson and Martin, from the Temblor horizon (lower middle Miocene) near Barker's Ranch, Kern County, is a typical *Melanella.*

According to Hanna (Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 174, 1924) the cotypes of "*Eulimella*" *ochsneri* Anderson and Martin, from the Barker's Ranch Miocene, show that species to belong to *Odostomia.*

Genus STROMBIFORMIS Da Costa, 1778

Strombiformis Da Costa, Brit. Conch., p. 107, 1778; Iredale, Proc. Malac. Soc. London, Vol. 11, p. 293, 1925; Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 339, 1917.

Type (by subsequent designation, Iredale, 1915), *Strombiformis glaber* Da Costa.

Melanellids with very narrow, elongated aperture, having the inner lip appressed to the attenuated basal portion of the preceding whorls; marked with one or more spiral color bands. (Bartsch.)

Strombiformis raymondi (Rivers)

Eulima raymondi Rivers, Bull. So. Calif. Acad. Sci., Vol. 3, no. 5, p. 70, May, 1904; no. 6, plate (no number), figs. 2, June, 1904, misspelled "*ramondi.*"

Strombiformis riversi Bartsch, Proc. U. S. Nat. Mus., Vol. 53, p. 339, pl. 45, fig. 3, 1917.

Type specimens: Of *raymondi,* in the River's collection ?; of *riversi,* No. 251,390, U. S. National Museum.

Type localities: Of *raymondi,* "Pleistocene, Santa Monica Range, Cal."; of *riversi,* "in the upper San Pedro series, at Santa Monica Canyon, California."

Pleistocene: Santa Monica Canyon, Santa Monica Range, Los Angeles County.

Although we have not seen the type specimen of "*Eulima*" *raymondi* the figures and descriptions of it and of *riversi* Bartsch leave little doubt about their being the same species. *Strombiformis californica* Bartsch[1] of the Recent southern California fauna is so similar that it should be considered a variety. Bartsch points out that *Strombiformis townsendi*,[2] of the Gulf of California fauna, resembles *californica*.

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[1] Univ. Wash. Publ. Geol., Vol. 1, no. 2, p. 85, pl. 7, fig. 22, January, 1922. The type locality is "the Greece Ranch" and the age presumed to be lower Oligocene but may be upper Eocene.

[2] Trans. Kansas Acad. Sci., Vol. 22, p. 223, pl. 6, fig. 61, 1909. Dall studied Reagan's types and concluded "*Eulima*" *smithi* was a synonym of *Strombiformis washingtoni* (Reagan).

[3] When this paper was in galley proof it was discovered that Van Winkle's *Eulima smithi* had been renamed "*Pyramidella* (?) *præcursor*" by Hanna, Proc. Calif. Acad. Sci., Ser. 4, Vol. 13, p. 178, 1924, which precludes the possibility of selecting better type material.

"*Eulima*" *washingtoni* Reagan (Trans. Kansas Acad. Sci., Vol. 22, p. 223, pl. 6, fig. 60, November, 1909) is a *Strombiformis*, according to Dall (Amer. Journ. Sci., Ser. 5, Vol. 4, p. 313, 1922), of which "*Eulima*" *smithi* Reagan (*non* Van Winkle) is a synonym. The age of Reagan's species is probably upper Miocene, not Pliocene as stated by Reagan.

Family PYRAMIDELLIDAE

The *Pyramidellidæ* have been studied in detail by Dall and Bartsch, whose publications[3] should be referred to for descriptions of the known genera, subgenera, sections, and species. Observations similar to those noted under the *Melanellidæ* are probably applicable here also. Many supposed species should be recognized as synonyms. Perhaps none of the Pleistocene species is extinct.

The species of the *Pyramidellidæ* have small, slender shells, characterized by protoconchs coiled in oblique or reverse directions.

Genus PYRAMIDELLA Lamarck, 1799

Subgenus LONGCHAEUS Mörch, 1875

Pyramidella (Longchæus) mexicana (Dall and Bartsch in Arnold)

Turbonilla mexicana Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 280, 1903.

Pyramidella conica Adams, var. *variegata* Carpenter, Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 280, 1903, not of Carpenter, 1864.

Pyramidella (*Longchæus*) *mexicana* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 23, pl. 1, fig. 12, 1909; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 87, 1927.

Longchæus mexicanus Dall and Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 120, 1921.

Pleistocene: Upper San Pedro series of San Pedro, "rare" (Arnold, as *P. conica*, var. *variegata* Carpenter, "probably" *Turbonilla mexicana* Dall and Bartsch).

Recent: San Diego, California, to Scammon's Lagoon, Lower California, Mexico (Dall).

Genus TURBONILLA Risso, 1826

Subgenus TURBONILLA, s. s.

Shell often small and slender; without spiral sculpture but with prominent axial ribs extending from summits of whorls to umbilical region; columella straight or slightly twisted.

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[1] Proc. U. S. Nat. Mus., Vol. 53, p. 340, pl. 45, fig. 5, 1917.

[2] Bartsch, *op. cit.*, p. 340, pl. 46, fig. 4, 1917.

[3] Dall and Bartsch: "Synopsis of the Genera, Subgenera, and Sections of the Family Pyramidellidæ," Proc. Biol. Soc. Washington, Vol. 17, pp. 1-16, February 5, 1904.

Dall and Bartsch: "Notes on Japanese, Indo-Pacific, and American Pyramidellidæ," Proc. U. S. Nat. Mus., Vol. 33, pp. 321-369, pls. 17-26, 1906.

Dall and Bartsch: "The Pyramidellid Mollusks of the Oregonian Faunal Area," Proc. U. S. Nat. Mus., Vol. 33, pp. 491-534, pls. 44-48, December 31, 1907.

Dall and Bartsch: "A Monograph of West American Pyramidellid Mollusks," U. S. Nat. Mus., Bull. 68, 258 pp., 30 ppl., 1909

Bartsch: "Additions to the West American Pyramidellid Mollusk Fauna, with Descriptions of New Species," Proc. U. S. Nat. Mus., Vol. 42, pp. 261-289, pls. 35-38, May 17, 1912.

Turbonilla (Turbonilla) gilli Dall and Bartsch

Turbonilla (*Turbonilla*) *gilli* Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, pp. 493, 494, pl. 14, fig. 5, 1907; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 245, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 87, pl. 49, fig. 8, 1927.

Turbonilla gilli Dall and Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 120, 1921.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Catalina Island to San Diego, California.

Subgenus **CHEMNITZIA** d'Orbigny, 1839

Shell usually small and slender; spiral sculpture absent; axial sculpture consisting of prominent axial ribs which fuse or terminate at the lower periphery; intercostal spaces deep, terminating above or at basal periphery; base smooth; columella straight.

Turbonilla (Chemnitzia) æpynota Dall and Bartsch

Turbonilla (*Chemnitzia*) *æpynota* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 35, pl. 2, figs. 10, 10*a*, 1909; Dall, U. S. Nat. Mus., Bull. 112, p. 121, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 14, 1924; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 90, pl. 49, figs. 10, 10*a*, 1917.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, Los Angeles County (T. S. Oldroyd).
Recent: San Pedro, California, to San Martin Island, Lower California, Mexico (Dall).

Turbonilla (Chemnitzia) muricata (Carpenter)

Chemnitzia muricata Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 428, 1855-7; Brit. Assn. Adv. Sci., Rept. for 1856, pp. 260, 334, 1857.

Turbonilla (*Strioturbonilla*) *muricata* Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 270, 1903.

Turbonilla (*Chemnitzia*) *muricata* Carpenter, Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 36, pl. 2, fig. 9, 1909.

Pleistocene: Lower San Pedro series of San Pedro and Deadman Island, "rare"; upper San Pedro series of San Pedro and Los Cerritos, "rather common" (Arnold).
Recent: Mazatlan, Mexico (Carpenter).

Turbonilla (Chemnitzia) paramoea Dall and Bartsch

Chemnitzia similis C. B. Adams, Ann. Lyc. Nat. Hist. New York, Vol. 5, p. 392, 1852, name preoccupied ?

Turbonilla (*Strioturbonilla*) *similis* C. B. Adams, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 270, 1903.

Turbonilla (*Chemnitzia*) *paramoea* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 37, pl. 2, figs. 4, 4*a*, 1909.

Pleistocene: Lower San Pedro series at Deadman Island and San Pedro, "rare"; upper San Pedro series at San Pedro and Los Cerritos, "common" (Arnold).
Recent: Panama (Adams).

Subgenus **STRIOTURBONILLA** Sacco, 1892

Shell with fine, close spiral striations on the spire and base.[1]

Turbonilla (Strioturbonilla) buttoni Dall and Bartsch

Turbonilla (*Strioturbonilla*) *buttoni* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 43, pl. 3, figs. 4, 4*a*, 1909; Dall, Bull. 112, p. 121, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 95, 1927.

Turbanilla buttoni Dall and Bartsch, E. P. and E. M. Chace, Lorquinia, Vol. 2, p. 42, 1919.

Pleistocene: Point Firmin chiton bed, Los Angeles County (Chace).
Recent: Santa Rosa Island, California, to Point Abreojos, Lower California, Mexico (Dall).

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[1] Mr. George Willett, of the Los Angeles Museum, points out that many specimens of some of the California species assigned to *Strioturbonilla* do not show any evidence of spiral striations.

Turbonilla (Strioturbonilla) asser Dall and Bartsch

Turbonilla (Strioturbonilla) asser Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 45, pl. 3, figs. 1, *1a*, 1909; Bull. 112, p. 122, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 14, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 97, 1927.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, Los Angeles County (T. S. Oldroyd); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Redondo Beach to San Diego, California (Dall).

Turbonilla (Strioturbonilla) stylina (Carpenter)

Chemnitzia (? torquata var.) *stylina* Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 396, 1865.
Turbonilla stylina Carpenter, Newcombe, Nautilus, Vol. 10, pp. 17, 20, 1896.
Turbonilla (Strioturbonilla) torquata, variety *stylina* Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 272, pl. 1, figs. 10, *10a*, 1903.
Turbonilla (Striaturbonilla) stylina Carpenter, Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 48, pl. 3, figs. 7, *7a*, 1909; Dall, Bull. 112, p. 122, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 100, 1927.

Pleistocene: San Pedro and San Diego, "abundant" (Arnold); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Monterey to the Coronado Islands, off San Diego, California.

Turbonilla (Strioturbonilla) torquata (Gould)

Chemnitzia torquata Gould, Boston Journ. Nat. Hist., Vol. 4, p. 384, 1852.
Turbonilla torquata Gould, Baker, Nautilus, Vol. 16, p. 41, 1902.
Turbonilla (Strioturbonilla) torquata Gould, Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 47, pl. 4, figs. 15, *15a*, 1909; not *T. (S.) torquata* Gould, of Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 271, pl. 2, figs. 4, *4a*, 1903, = *T. (S.) ralphi* Dall and Bartsch, 1909.

Recent: Point Firmin, Los Angeles County, California, to San Martin Island, Lower California, Mexico (Baker).

Turbonilla (Strioturbonilla) ralphi Dall and Bartsch

"*Turbonilla (Strioturbonilla) torquata* Gould," Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 271, pl. 2, figs. 4, *4a*, 1903, not *Chemnitzia torquata* Gould, 1852.
Turbonilla (Strioturbonilla) ralphi Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 47, 1909.

Pleistocene: San Pedro and San Diego, abundant (Arnold).

Turbonilla (Strioturbonilla) attrita Dall and Bartsch

Turbonilla (Strioturbonilla) attrita Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 46, pl. 4, figs. 11, *11a*, 1909; Dall, Bull. 112, p. 122, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 97, 1927.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro to San Diego, California (Dall).

Turbonilla (Strioturbonilla) simpsoni Dall and Bartsch

Turbonilla (Strioturbonilla) simpsoni Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 49, pl. 3, figs. 6, *6a*, 1909; Dall' Bull. 112, p. 122, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 101, 1927.
Turbonilla (Strioturbonilla) cf. *simpsoni* Dall and Bartsch, Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

? Pliocene: Pico formation near Ventura (listed doubtfully by Waterfall).
Recent: Off Redondo, Los Angeles County, to San Diego, California (Dall).

Turbonilla (Strioturbonilla) carpenteri Dall and Bartsch

Turbonilla (Strioturbonilla) carpenteri Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 49, pl. 3, figs. 9, 9*a*, 1909; Dall, Bull. 112, p. 122, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 100, 1927; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pleistocene: "Saugus" formation near Ventura (Waterfall).
Recent: San Pedro, California (Dall).

Turbonilla (Strioturbonilla) aresta Dall and Bartsch

Turbonilla (Strioturbonilla) aresta Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 54, pl. 4, figs. 5, 5*a*, 1909; Dall, Bull. 112, p. 123, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 14, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 105, 1927.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro, "one specimen" (T. S. Oldroyd).
Recent: Santa Rosa Island to San Diego, California (Dall).

Turbonilla (Strioturbonilla) stearnsii Dall and Bartsch in Arnold

Turbonilla (Strioturbonilla) stearnsii Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 271, pl. 2, figs. 5, 5*a*, 1903.

Pleistocene: San Pedro and San Diego, abundant (Arnold).
Recent: Gulf of California, Mexico.

Turbonilla (Strioturbonilla) pecora T. S. Oldroyd

Turbonilla pecora T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 24, pl. 1, fig. 6, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County (Oldroyd).

Subgenus **PYRGOLAMPROS** Sacco, 1892

Turbonillas with low, broad, rounded vertical ribs, which almost always disappear as they pass over the periphery and base of the last whorl, and many very fine, faint, wavy spiral striations; surface covered by a thin epidermis; columella usually somewhat flexuose. (Dall and Bartsch, 1909.)

Turbonilla (Pyrgolampros) valdezi Dall and Bartsch

"*Turbonilla (Pyrgolampros) gibbosa* Carpenter," Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 279, pl. 1, figs. 2, 2*a*, 1903, not *Chemnitzia gibbosa* Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 430, 1857.

Turbonilla (Pyrgolampros) valdezi Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 502, pl. 44, figs. 3, 3*a*, 1907; U. S. Nat. Mus., Bull. 68, p. 62, pl. 6, fig. 8, 1909; Dall, Bull. 112, p. 123, 1921.

Pleistocene: Lower San Pedro series of Deadman Island (Arnold).
Recent: Barkley Sound, Vancouver Island, British Columbia, to Monterey, California (Dall).

Turbonilla (Pyrgolampros) lowei Dall and Bartsch in Arnold

Turbonilla (Pyrgolampros) lowei Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 278, pl. 1, figs. 5, 5*a*, 1903; U. S. Nat. Mus., Bull. 68, p. 64, pl. 6, figs. 11, 11*a*, 1909; Dall, Bull. 112, p. 123, 1921.

Pleistocene: San Pedro and San Diego (Arnold).
Recent: San Pedro to San Diego, California (Dall).

Turbonilla (Pyrgolampros) gouldi Dall and Bartsch

Turbonilla (Pyrgolampros) gouldi Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 66, pl. 6, figs. 1, 1*a*, 1909; Dall, Bull. 112, p. 123, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Santa Rosa Island to San Diego, California.

Turbonilla (Pyrgolampros) aurantia (Carpenter)

Chemnitzia (? var.) *aurantia* Carpenter, Journ. de Conchyl., Vol. 12, p. 147, 1865.
Turbonilla (*Lancea*) *aurantia* Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 272, 1903.
Turbonilla (*Pyrgolampros*) *aurantia* Carpenter, Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 502, pl. 45, fig. 5, 1907; U. S. Nat. Mus., Bull. 68, p. 66, pl. 6, fig. 4, 1909; Dall, Bull. 112, p. 123, 1921.

Pleistocene: Lower and upper San Pedro series of San Pedro region (Arnold).
Recent: Departure Bay, Victoria, British Columbia, and Puget Sound (Dall).

Turbonilla (Pyrgolampros) pedroana Dall and Bartsch in Arnold

Turbonilla (*Pyrgolampros*) *lowei*, var. *pedroana* Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 279, pl. 2, figs. 3, 3*a*, 1903.
Turbonilla (*Pyrgolampros*) *pedroana* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 67, pl. 6, figs. 12, 12*a*, 1909; Dall, Bull. 112, p. 123, 1921.

Pleistocene: Spanish Bight, San Diego (Arnold).
Recent: Victoria, British Columbia, to San Diego, California (Dall).

Turbonilla (Pyrgolampros) adleri Dall and Bartsch in Arnold

Turbonilla (*Pyrgolampros*) *adleri* Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 280, pl. 1, fig. 9, 1903.
Turbonilla (*Pyrgolampros*) *alderi* Dall and Bartsch, Schuchert, U. S. Nat. Mus., Bull. 53, Pt. 1, p. 673, 1905, catalogue entry only.

Pleistocene: Deadman Island, Los Angeles County.

Turbonilla (Pyrgolampros) amara Bartsch

Turbonilla (*Pyrgolampros*) *amara* Bartsch, Proc. Biol. Soc. Wash., Vol. 31, p. 81, 1918.

Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles County.

Turbonilla (Pyrgolampros) arnoldi Dall and Bartsch in Arnold

Turbonilla (*Pyrgolampros*) *arnoldi* Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 279, pl. 1, fig. 7, 1903.

Pleistocene: Lower San Pedro series of Deadman Island, Los Angeles County.

Turbonilla (Pyrgolampros) idæ T. S. Oldroyd

Plate 24, Figure 23

Turbonilla (*Pyrgolampros*) *idæ* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 26, pl. 1, fig. 9, 1925.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro (T. S. Oldroyd); S. D. S. N. H. localities 247 and 249, Kalorama Canyon, north of Ventura, and locality 233, north of Arroyo Santa Rosa, Ventura County (identifications by T. S. Oldroyd).

Turbonilla (Pyrgolampros) collisella T. S. Oldroyd

Turbonilla (*Pyrgolampros*) *collisella* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 25, pl. 1, fig. 11, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro.

Turbonilla (Pyrgolampros) gloriosa Bartsch

Turbonilla (*Pyrgolampros*) *gloriosa* Bartsch, Proc. U. S. Nat. Mus., Vol. 42, p. 268, pl. 35, fig. 9, 1912; Dall, U. S. Nat. Mus., Bull. 112, p. 124, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Off San Diego, California, in 12 fathoms (Bartsch).

Turbonilla (Pyrgolampros) hannibali Bartsch

Turbonilla (Pyrgolampros) hannibali Bartsch, Proc. U. S. Nat. Mus., Vol. 52, p. 645, pl. 43, fig. 7, 1917.

Pliocene: Elk River beds at the mouth of Elk River, Port Orford, Oregon, upper Pliocene (or lower Pleistocene).

Turbonilla (Pyrgolampros) hemphilli Bartsch

Turbonilla (Pyrgolampros) hemphilli Bartsch, Proc. U. S. Nat. Mus., Vol. 52, p. 646, pl. 44, fig. 8, 1917.

Pliocene: San Diego well, Balboa Park, San Diego, at depth of 140 feet.

Turbonilla (Pyrgolampros) rinella Dall and Bartsch

Turbonilla (Pyrgolampros) rinella Dall and Bartsch, Mem. Canadian Geol. Surv., Vol. 14, p. 14, pl. 1, fig. 2, 1910; Dall, U. S. Nat. Mus., Bull. 112, p. 124, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 14, 1925; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 120, 1927.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County (T. S. Oldroyd).
Recent: Barkley Sound, Vancouver Island, British Columbia (Dall).

Subgenus **PYRGISCUS** Philippi, 1841

Turbonillas having prominent axial ribs and deeply incised spiral lines but no varices or internal lirations on the outer lip; columella usually somewhat flexuous. (Dall and Bartsch.)

Turbonilla (Pyrgiscus) vexativa Dall and Bartsch

Turbonilla (Pyrgiscus) vexativa Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 77, pl. 7, fig. 11, 1909; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.
Pyrgiscus vexativus Dall and Bartsch, Dall, U. S. Nat. Mus., Bull. 112, p. 125, 1921.

Pleistocene: San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro to San Diego, California (Dall).

Turbonilla (Pyrgiscus) antestriata Dall and Bartsch

Turbonilla (Pyrgiscus) antestriata Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 506, pl. 45, figs. 4, 4*a*, 1907; U. S. Nat. Mus., Bull. 68, p. 87, pl. 8, figs. 5, 5*a*, 1909; Dall, Bull. 112, p. 126, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Esteros Bay to San Diego, California (Dall).

Turbonilla (Pyrgiscus) almo Dall and Bartsch

Turbonilla (Pyrgiscus) almo Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 95, pl. 9, figs. 8, 8*a*, 1909; Dall, Bull. 112, p. 126, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Diego, California.

Turbonilla (Pyrgiscus) tenuicula (Gould)

Chemnitzia tenuicula Gould, Boston Journ. Nat. Hist., Vol. 6, p. 383, pl. 14, fig. 15, 1853.
Chemnitzia terebralis Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 432, 1856.
Chemnitzia unifasciata Carpenter, *op. cit.*, p. 433, 1856.
Chemnitzia ? var. *subcuspidata* Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 659, 1864.
Chemnitzia crebrifilata Carpenter, Brit. Assn. Adv. Sci., Rept. for 1863, p. 659, 1864.
Turbonilla (Pyrgiscus) tenuicula Gould, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 275, pl. 2, figs. 7, 7*a*, 1903; Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 92, pl. 8, figs. 3, 7, 7*a*, 12, 12*a*, 14, 14*a*, 1909; Dall, Bull. 112, p. 126, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 14, 1925.

Turbonilla (Pyrgiscus) crebrifilata Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 276, pl. 2, figs. 6, 6*a*, 1903.
Turbonilla (Pyrgiscus) subcuspidata Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 277, pl. 2, figs. 2, 2*a*, 1903.

Pleistocene: San Pedro and San Diego regions.
Recent: Monterey, California, to Point Abreojos, Lower California, Mexico (Dall), and south ?

Turbonilla (Pyrgiscus) auricoma Dall and Bartsch in Arnold

Turbonilla (Pyrgiscus) auricoma Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 274, pl. 1 ,figs. 4, 4*a*, 1903; U. S. Nat. Mus., Bull. 68, p. 100, pl. 9, figs. 5, 5*a*, 1909; Dall, Bull. 112, p. 126, 1921.

Pleistocene: San Diego.
Recent: San Pedro, California, to Scammons Lagoon, Lower California, Mexico (Dall).

Turbonilla (Pyrgiscus) latifunda Dall and Bartsch in Arnold

Turbonilla (Pyrgiscus) latifunda Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 275, pl. 3, figs. 5, 5*a*, 1903.

Pleistocene: San Pedro and Deadman Island, Los Angeles County.

Turbonilla (Pyrgiscus) himerta T. S. Oldroyd

Turbonilla (Pyrgiscus) himerta T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, pp. 14, 27, pl. 1, fig. 1, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County.

Turbonilla (Pyrgiscus) hertleini E. K. Jordan

Turbonilla (Pyrgiscus) hertleini E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 252, pl. 25, fig. 6, 1926.

Pleistocene: Upper Pleistocene, San Quintin, Lower California, Mexico.

Subgenus **MORMULA** A. Adams, 1864

Turbonillas having axial ribs and deeply incised spiral lines; also irregularly disposed varices on the outer surface, which usually mark internal lirations on the outer lip, or internal lirations of the outer lip only; sculpture never nodulose. (Dall and Bartsch.)

Turbonilla (Mormula) catalinensis Dall and Bartsch

Turbonilla (Mormula) catalinensis Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 113, pl. 11, figs. 10, 10*a*, 1909; Dall, Bull. 112, p. 127, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: Catalina Island, California (Dall).

This species appears to be very closely related to *Turbonilla regina* Dall and Bartsch.

Turbonilla (Mormula) tridentata (Carpenter)

Chemnitzia tridentata Carpenter, Journ. de Conchyl., Vol. 13, p. 147, 1865.
Turbonilla (Lancea) tridentata Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 273, pl. 2, figs. 1, 1*a*, 1903.
Turbonilla (Mormula) tridentata Carpenter, Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 511, pl. 45, fig. 9, 1907; U. S. Nat. Mus., Bull. 68, p. 114, pl. 11, figs. 12, 12*a*, 1909; Dall, Bull. 112, p. 127, 1921.
Turbonilla (Mormula) ambusta Dall and Bartsch, Bull. 68, U. S. Nat. Mus., p. 115, pl. 11, fig. 13, 1909; Dall, Bull. 112, p. 127, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 148, pl. 56, fig. 13, 1927.

Pleistocene: San Pedro region, Los Angeles County.
Recent: Monterey to San Diego, California.

Mr. George Willett has called attention to a series of specimens of *tridentata* in his collection which shows complete intergradation in number of axial ribs and spiral striations with *ambusta* Dall and Bartsch, which name, therefore, must fall into synonymy. *Turbonilla regina* and *catalinensis,* both of Dall and Bartsch, are similar but appear to be consistently larger. *Turbonilla lordi* E. A. Smith is a similar large northern shell, but it has distinct color bands when fresh.

Turbonilla (Mormula) pentalopha Dall and Bartsch in Arnold

Turbonilla (*Lancea*) *pentalopha* Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 274, pl. 1, figs. 1, 1*a*, 1903.

Turbonilla (*Mormula*) *pentalopha* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 117, pl. 11, figs. 3, 3*a*, 1909; Dall, Bull. 112, p. 127, 1921.

Pleistocene: Deadman Island, San Pedro, Los Angeles County.
Recent: San Pedro, California, to Todos Santos Bay, Lower California, Mexico (Dall).

Turbonilla (Mormula) epiphanea T. S. Oldroyd

Turbonilla (*Mormula*) *epiphanea* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 28, pl. 1, fig. 12, 1925.

Pleistocene: Lower San Pedro series at Nob Hill cut, San Pedro, Los Angeles County (Oldroyd).

Subgenus **BARTSCHELLA** Iredale, 1916

Turbonilla (Bartschella) laminata (Carpenter)

Dunkeria laminata Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 396, 1865.

Turbonilla (*Pyrgiscus*) *laminata* Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 277, pl. 2, figs. 8, 8*a*, 1903.

Turbonilla (*Dunkeria*) *laminata* Carpenter, Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 122, pl. 12, figs. 16, 16*a*, 1909.

Turbonilla (*Bartschella*) *laminata* Carpenter, Dall, U. S. Nat. Mus., Bull. 112, p. 127, 1921; T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65; Art. 22, p. 14, 1925; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro (Oldroyd), and of San Pedro Bluffs and Deadman Island; Barlow's Ranch, near Ventura; upper San Pedro series of the lumber yard at San Pedro and of Los Cerritos, Los Angeles County (Arnold); upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro, California, to Point Abreojos, Lower California, Mexico (Dall).

Genus **ODOSTOMIA Fleming, 1817**

Odostomia Fleming, Edinburgh Encycl., Vol. 7, Pt. 1, p. 76, 1817.

Shell with sinistral apex, usually short, few whorled, subconic or ovate, with a single columellar fold, which varies in strength and sometimes is not apparent at the aperture; sculpture varying from smooth to lamellar ribs and spiral keels. (Dall and Bartsch, 1909.)

Subgenus **CHRYSALLIDA** Carpenter, 1856

Chrysallida Carpenter, Cat. Reigen Coll. Mazatlan Moll. Brit. Mus., p. 416, 1856.

Odostomias with strong axial ribs crossed by equally strong spiral keels between the sutures, the intersection of these two elements forming nodules. The axial ribs pass only faintly over the base, while the spiral sculpture remains quite prominent. (Dall and Bartsch.)

Odostomia (Chrysallida) diegensis Dall and Bartsch in Arnold

Odostomia (*Chrysallida*) *diegensis* Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 284, pl. 1, fig. 8, 1903.

Pleistocene: San Diego.

Odostomia (Chrysallida) gomphina T. S. Oldroyd

Odostomia (*Chrysallida*) *gomphina* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 29, pl. 1, fig. 3, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County.

Odostomia (Chrysallida) scelera T. S. Oldroyd

Odostomia (*Chrysallida*) *scelera* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 30, pl. 1, fig. 4, 1925.

Pleistocene: Lower San Pedro fauna of Nob Hill cut, San Pedro.

Odostomia (Chrysallida) dallasi E. K. Jordan

Odostomia (*Chrysallida*) *dallasi* E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 253, pl. 25, fig. 4, 1926.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico.

Subgenus **IVIDELLA** Dall and Bartsch, 1909

Odostomias with lamellar spiral ridges and equally strong lamellar axial ribs, both of which ornament spire and base. (Dall and Bartsch.)

Odostomia (Ividella) pedroana Dall and Bartsch

Odostomia (*Ividella*) *pedroana* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 172, pl. 19, figs. 8, 8*a*, 1909; Dall, Bull. 112, p. 130, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).

Odostomia (Ividella) navisa Dall and Bartsch variety **delmontensis** Dall and Bartsch

Odostomia (*Ividia*) *navisa delmontensis* Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 518, pl. 46, figs. 3, 3*a*, 1907.
Odostomia (*Ividella*) *navisa delmontensis* Dall and Bartsch, Bull. 68, p. 174, pl. 18, figs. 10, 10*a*, 1909; Dall, Bull. 112, p. 130, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: San Quintin Bay, Lower California, Mexico.
Recent: Off Del Monte, Monterey Bay, California.

Subgenus **IVARA** Dall and Bartsch in Arnold, 1903

Ivara Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 285, 1903, monotype *O. terricula* = *O. turricula* Carpenter MS. in Dall and Bartsch in Arnold; Proc. Biol. Soc. Wash., Vol. 17, p. 11, 1904.

Odostomias having feebly developed axial ribs, which are usually only indicated near the summits of the whorls; spiral sculpture consisting of many subequally-spaced fine lirations; summits of the whorls strongly tabulated. (Dall and Bartsch.)

Odostomia (Ivara) turricula Carpenter MS. in Dall and Bartsch in Arnold

"*Odostomia* (*Ivara*) *terricula* (Carpenter)" Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 285, pl. 4, fig. 14, 1903, misprint for *turricula*, assigned to Carpenter, possibly through error.
Odostomia (*Ivara*) *turricula* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 179, pl. 19, fig. 9, 1909.
"*Ivara terricula* Dall and Bartsch," Dall, U. S. Nat. Mus., Bull. 112, p. 130, 1921.

Pleistocene: Lower San Pedro series of Deadman Island, "one specimen" (Arnold).
Recent: Monterey, California, to Point Abreojos, Lower California.

Odostomia (Ivara) amava T. S. Oldroyd

Odostomia (*Ivara*) *amava* T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 29, pl. 1, fig. 7, 1925.

Pleistocene: Nob Hill cut, San Pedro.

Subgenus **IOLAEA** A. Adams, 1867

Iolæa A. Adams, Proc. Zool. Soc. London for 1867, p. 310; Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 181, 1909.

Shell umbilicated, marked by spiral cords and axial riblets, the axial riblets crossing the grooves between the spirals. (Dall and Bartsch, altered.)

Odostomia (Iolæa) eucosmia Dall and Bartsch

Oscilla insculpta (Carpenter) Keep, West Coast Shells, p. 52, 1888, not *Odostomia insculpta* De Kay, 1843.

Odostomia (*Iolæa*) *eucosmia* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 183, pl. 20, figs. 10, 10*a*, 1909; Dall, Bull. 112, p. 130, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene of San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Pedro, California, to Point Abreojos, Lower California, Mexico (Jordan).

Subgenus **MENESTHO** Möller, 1842

Menestho Möller, Index Moll. Groenl., p. 10, 1842; Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 184, 1909.

Shell not umbilicated, marked by moderately well developed and usually equally spaced spiral cords; axial sculpture reduced to mere lines of growth, which frequently appear as *very slender* raised threads in the grooves between the cords. (Dall and Bartsch.)

Odostomia (Menestho) grammatospira Dall and Bartsch in Arnold

Odostomia (*Oscilla*) *grammatospira* Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 285, pl. 1, figs. 6, 6*a*, 1903.

Odostomia (*Menestho*) *grammatospira* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 185, pl. 21, figs. 7, 7*a*, 1909.

Pleistocene: San Diego.
Recent: Lower California, Mexico.

Odostomia (Menestho) æquisculpta Carpenter

Odostomia (*Evalea*) *æquisculpta* Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 14, p. 46, 1864.

Odostomia (*Oscilla*) *æquisculpta* Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 284, pl. 1, figs. 3, 3*a*, 1903.

Odostomia (*Menestho*) *æquisculpta* Carpenter, Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 191, pl. 20, figs. 3, 3*a*, 1909.

Pleistocene: San Diego.
Recent: Cape San Lucas, Lower California, Mexico.

Subgenus **EVALEA** A. Adams, 1860

Evalea A. Adams, Ann. Mag. Nat. Hist., Ser. 3, Vol. 6, p. 22, 1860.

Odostomias with the surface marked by fine, incised spiral lines. (Dall and Bartsch.)

Odostomia (Evalea) io Dall and Bartsch

"*Odostomia tenuis* Carpenter," Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 281, pl. 1, fig. 14, 1903, not of Carpenter, 1856.

Odostomia (*Evalea*) *io* Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 199, pl. 22, fig. 4, 1909; Dall, Bull. 112, p. 133, 1921; Waterfall, Univ. Calif. Publ. Geol., Vol. 18, p. 78, 1929.

Pliocene: "Pico" formation near Ventura (Waterfall).
Pleistocene: "Saugus" formation near Ventura (Waterfall); rare in lower and upper San Pedro formations in San Pedro region, Los Angeles County; also in the Pleistocene near Ventura and at San Diego (Arnold).
Recent: Santa Rosa Island to San Pedro and Catalina Island, California.

Odostomia (Evalea) phanea Dall and Bartsch

Plate 24, Figure 25

"*Odostomia (Evolea) gouldii* Carpenter," Dall and Bartsch, in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 282, pl. 1, fig. 15, 1903.

Odostomia (Evalea) phanea Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 528, pl. 48, fig. 7, 1907; Bull. 68, U. S. Nat. Mus., p. 204, pl. 23, fig. 5, 1909; Dall, Bull. 112, p. 134, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 200, pl. 63, fig. 5, 1927.

Pleistocene: San Diego, San Pedro, and Ventura (Dall and Bartsch in Arnold, 1903); upper Pleistocene terrace southwest of Goleta, Santa Barbara County (coll. by U. S. G.).
Recent: Monterey, California.

This species has a prominent oblique fold on the upper part of the columella. In this character and in general shape it is like *O.* (*Amaura*) *gouldii* Carpenter. A specimen from the late Pleistocene sands southwest of Goleta appears to belong to this species. Compare also plate 32, figure 20.

Odostomia (Evalea) minutissima Dall and Bartsch

Odostomia (Evalea) minutissima Dall and Bartsch, U. S. Nat. Mus., Bull. 68, p. 211, pl. 25, fig. 4, 1909; Dall, Bull. 112, p. 134, 1921; E. K. Jordan, Proc. Calif. Acad. Sci., Ser. 4, Vol. 15, p. 246, 1926.

Pleistocene: Upper Pleistocene at San Quintin Bay, Lower California, Mexico (Jordan).
Recent: San Diego, California, to Point Abreojos, Lower California, Mexico (Dall).

Odostomia (Evalea) orfordensis Bartsch

Odostomia (Evalea) orfordensis Bartsch, Proc. U. S. Nat. Mus., Vol. 52, p. 667, pl. 43, fig. 2, May 29, 1917.

Pliocene: Elk River beds, mouth of Elk River, Port Orford, Oregon, upper Pliocene (Bartsch).

Odostomia (Evalea) pleioregona Bartsch

Odostomia (Evalea) pleioregona Bartsch, Proc. U. S. Nat. Mus., Vol. 52, p. 666, pl. 42, fig. 5, pl. 45, fig. 6, 1917.

Pliocene: Elk River beds, mouth of Elk River, Port Orford, Oregon, upper Pliocene (Bartsch).

Odostomia (Evalea) teresa T. S. Oldroyd

Odostomia (Evalea) teresa T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 31, pl. 1, fig. 10, 1925.

Pleistocene: Lower San Pedro series of Nob Hill cut, San Pedro, Los Angeles County (T. S. Oldroyd).

Odostomia (Evalea) civitella T. S. Oldroyd

Odostomia (Evalea) civitella T. S. Oldroyd, *op. cit.*, p. 32, pl. 2, fig. 7, 1925.

Pleistocene: Nob Hill cut, San Pedro.

Odostomia (Evalea) fitella T. S. Oldroyd

Odostomia (Evalea) fitella T. S. Oldroyd, *op. cit.*, p. 33, pl. 1, fig. 8, 1925.

Pleistocene: Nob Hill cut, San Pedro.

Odostomia (Evalea) ithea T. S. Oldroyd

Odostomia (Evalea) ithea T. S. Oldroyd, *op. cit.*, p. 31, pl. 1, fig. 2, 1925.

Pleistocene: Nob Hill cut, San Pedro.

Odostomia (Evalea) manca T. S. Oldroyd

Odostomia (*Evalea*) *manca* T. S. Oldroyd, *op. cit.*, p. 32, pl. 1, fig. 5, 1925.

Pleistocene: Nob Hill cut, San Pedro.

Odostomia (Evalea) stearnsii Dall and Bartsch in Arnold

Odostomia (*Evalea*) *stearnsii* Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 282, pl. 1, fig. 12, 1903.

Pleistocene: San Diego.

Subgenus **AMAURA** Möller, 1842

Amaura Möller, Index Moll. Groenlandica, p. 7, 1842.

Very large, usually inflated Odostomias, the sculpture of which consists of very fine lines of growth and still finer, wavy, closely placed spiral striations. (Dall and Bartsch.)

Odostomia (Amaura) satura Carpenter

Odostomia satura Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 29, 1865.
Odostomia satura var. *pupiformis* Carpenter, *op. cit.*, p. 29, 1865.
Odostomia (*Amaura*) *pupiformis* Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 283, pl. 1, fig. 13, 1903.
Odostomia (*Amaura*) *satura* (Carpenter), Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 529, pl. 48, figs. 5, 5*a*, 1907; U. S. Nat. Mus., Bull. 68, p. 221, pl. 27, fig. 1, 1909; Dall, Bull. 112, p. 136, 1921.

Pleistocene: San Diego, California (Dall and Bartsch in Arnold, 1903).
Recent: Neah Bay, Washington (Dall and Bartsch).

Odostomia (Amaura) gouldii Carpenter

Odostomia (? var.) *gouldii* Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 29, 1865.
Odostomia (*Evalea*) *gouldi* Carpenter, Dall and Bartsch, Proc. U. S. Nat. Mus., Vol. 33, p. 531, pl. 48, fig. 4, 1907; Bull. 68, U. S. Nat. Mus., p. 224, pl. 27, fig. 2, 1909; Dall, Bull. 112, p. 136, 1921; not of Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 282, pl. 1, fig. 15, 1903, = *O.* (*Evalea*) *phanea*.

Type specimen: In the U. S. National Museum, No. 22,821.

Type locality: Neah Bay, Washington.

Recent: Neah Bay, Washington (Carpenter).

This species is similar to *Odostomia* (*Evalea*) *phanea* Dall and Bartsch, but is distinguished by subgeneric characters. It does not appear to have been correctly reported as a fossil.

Odostomia (Amaura) avellana Carpenter

Cf. Plate 32, Figure 20

Odostomia (? var.) *avellana* Carpenter, Ann. Mag. Nat. Hist., Ser. 3, Vol. 15, p. 30, 1865.
Odostomia (*Amaura*) *nuciformis avellana* Carpenter, Dall and Bartsch in Arnold, Mem. Calif. Acad. Sci., Vol. 3, p. 283, pl. 1, fig. 11, 1903; Proc. U. S. Nat. Mus., Vol. 33, p. 530, pl. 48, figs. 1, 1*a*, 1907; U. S. Nat. Mus., Bull. 68, p. 225, pl. 28, fig. 3, 1909; Dall, Bull. 112, p. 136, 1921; I. S. Oldroyd, Stanford Univ. Publ. Geol., Vol. 2, Pt. 2, p. 212, pl. 64, fig. 3, 1927.

Pleistocene: Deadman Island, Los Angeles County, and Ventura; ? upper Pleistocene southwest of Goleta, Santa Barbara Co.
Recent: Neah Bay, Washington.

Odostomia (Amaura) menzola T. S. Oldroyd

Odostomia (Amaura) menzola T. S. Oldroyd, Proc. U. S. Nat. Mus., Vol. 65, Art. 22, p. 33, pl. 2, fig. 6, 1925.

Pleistocene: Nob Hill cut, San Pedro, Los Angeles County, as lower San Pedro series (Oldroyd).

Odostomia (Amaura) sanesia T. S. Oldroyd

Odostomia (Amaura) sanesia T. S. Oldroyd, *op. cit.*, p. 34, pl. 1, fig. 13, 1925.

Pleistocene: Nob Hill cut, San Pedro.

Odostomia (Amaura) timessa T. S. Oldroyd

Odostomia (Amaura) timessa T. S. Oldroyd, *op. cit.*, p. 35, pl. 2, fig. 4, 1925.

Pleistocene: Nob Hill cut, San Pedro.

Odostomia (Amaura) trochilia T. S. Oldroyd

Odostomia (Amaura) trochilia T. S. Oldroyd, *op. cit.*, p. 34, pl. 2, fig. 1, 1925.

Pleistocene: Nob Hill cut, San Pedro.

The type specimens of the forms named by T. S. Oldroyd in 1925 are in the U. S. National Museum.

CLASS AMPHINEURA

The Amphineura are a group of bilaterally symmetrical mollusks commonly grouped with the gastropods as a subclass but in many ways quite distinct. They are subdivided into the order Polyplacophora, including the chitons, and the order Aplacophora. The latter lack the plates and are practically without the foot of the former. They have not been found fossil in California. The Polyplacophora, or chitons, are elongate animals, adhering to rocks or other objects by a foot that is coextensive with the body. Dorsally they are provided with eight transverse chitonous plates or valves. These valves are occasionally found as fossils; but except for a few unusual localities, they are relatively rare. Limitations of time and space made it necessary to omit a treatment of the group in this memoir.

The following are some of the more important references to the occurrence of chitons as fossils on the Pacific coast of North America:

Arnold, R., Mem. Calif. Acad. Sci., Vol. 3, pp. 342-343, 1903.
Berry, S. S.: "Preliminary Notices of Some New West American Chitons," Lorquinia (Los Angeles), Vol. 2, No. 6, pp. 4-7, January, 1919.
————: "Fossil Chitons of Western North America," Proc. Calif. Acad. Sci., Ser. 4, Vol. 11, pp. 399-526, ppl. 1-16, also text figs., May 16, 1922.
————: "Fossil Chitons from the Pleistocene of San Quintin Bay, Lower California," Amer. Journ. Sci., Ser. 5, pp. 455-456, November, 1926.

A checklist of the Recent occurrences from California northward is given by Dall, and data on Recent species is also given by Oldroyd:

Dall, W. H., Bull. 112, U. S. Nat. Mus., pp. 186-199, 1921.
Oldroyd, I. S., Stanford Univ. Publ. Geol., Vol. 2, Pt. 3, pp. 246-323, 1927.

In 1927, the Royal Society of New South Wales published a monograph of the Australian Loricates by Iredale and Hull containing much generic discussion of importance to those interested in the systematics of this group.

In concluding it might be well to mention that the species in some of the groups of chitons have been overnamed.

PLATES 1-32

EXPLANATION OF PLATE 1

FIG. 1. *Yoldia scissurata* Dall, Recent specimen from Puget Sound, labeled A in the collection at Stanford University. Right valve, length 36 mm . . . . page 131

FIGS. 2. *Nuculana minuta* (Müller, 1776), reproduction of figures of a Recent specimen from Greenland by Hanley in Sowerby, Thes. Conch., Vol. 3, p. 114, *Nuculidæ*, pl. 3, figs. 61, 62, 1860. Fig. 2*a*, umbonal view; fig. 2*b*, right valve; length 14 mm . . . . page 122

FIGS. 3. *Nucula* (*Acila*) *mirabilis* Adams and Reeve, Recent specimen from Japan, labeled 308A in the collection at Stanford University. Fig. 3*a*, left valve; fig. 3*b*, posterior view; length 23 mm. This species is practically indistinguishable from the well-known *Nucula* (*Acila*) *gettysburgensis* Reagan of the Oligocene of Washington . . . . page 113

FIG. 4. *Nucula* (*Nucula*) *nucleus* (Linnæus), Recent specimen from England or France, labeled 1362A in the collection at Stanford University. Exterior of left valve, length 7 mm . . . . page 110

FIG. 5. *Nucula* (*Nucula*) *nucleus* (Linnæus), another specimen from the same lot as that shown in fig. 4. Interior of left valve, length 9 mm. This species is the type of the genus *Nucula* Lamarck . . . . page 110

FIGS. 6. *Nucula* (*Acila*) *castrensis* Hinds, Recent specimen from Puget Sound, labeled A in the collection at Stanford University. Fig. 6*a*, exterior of left valve; fig. 6*b*, interior of left valve; length 17 mm . . . . page 116

FIG. 7. *Yoldia limatula* (Say), Recent specimen from Puget Sound, labeled A in the collection at Stanford University. Exterior of left valve, length 28 mm . . . . page 131

FIG. 8. *Nuculana taphria* (Dall), specimen No. 77 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, Los Angeles Co. Exterior of right valve, partial length 17 mm. Unfortunately the shapes of figs. 8 and 9, as well as those of some of the Nuculas, have been injured somewhat during the preparation of the plates . . . . page 121

FIG. 9. *Nuculana taphria* (Dall), specimen No. 78 S. D. S. N. H., from locality 98, Pleistocene near Goleta, Santa Barbara Co. Exterior of right valve, length 16 mm . . . . page 121

FIG. 10. *Yoldia arctica* (Gray), typical variety, reproduction of a figure of a Recent specimen from the Lapteff Sea (75° 42′ N., 124° 41′ E.) by Mossevitch, Acad. Sci. Union Rép. Sov. Soc., Livraison 19, pl. 1, fig. 3, 1928. Exterior of right valve, probably enlarged × 2. This species is the type of the genus *Yoldia* Möller . . . . pages 126, 127

FIG. 11. *Yoldia arctica* (Gray), typical variety, reproduction of Mossevitch's fig. 1, of a specimen from deep water in the White Sea to show the variation that Mossevitch recognizes even in the typical variety. Mossevitch records many specimens and several other varieties. Exterior of right valve, probably enlarged × 2 . . . . pages 126, 127

FIGS. 12. *Yoldia thraciæformis* (Storer), Recent specimen from Puget Sound, labeled A in the collection at Stanford University. Fig. 12*a*, interior of right valve; fig. 12*b*, exterior of left valve; length 44 mm . . . . page 128

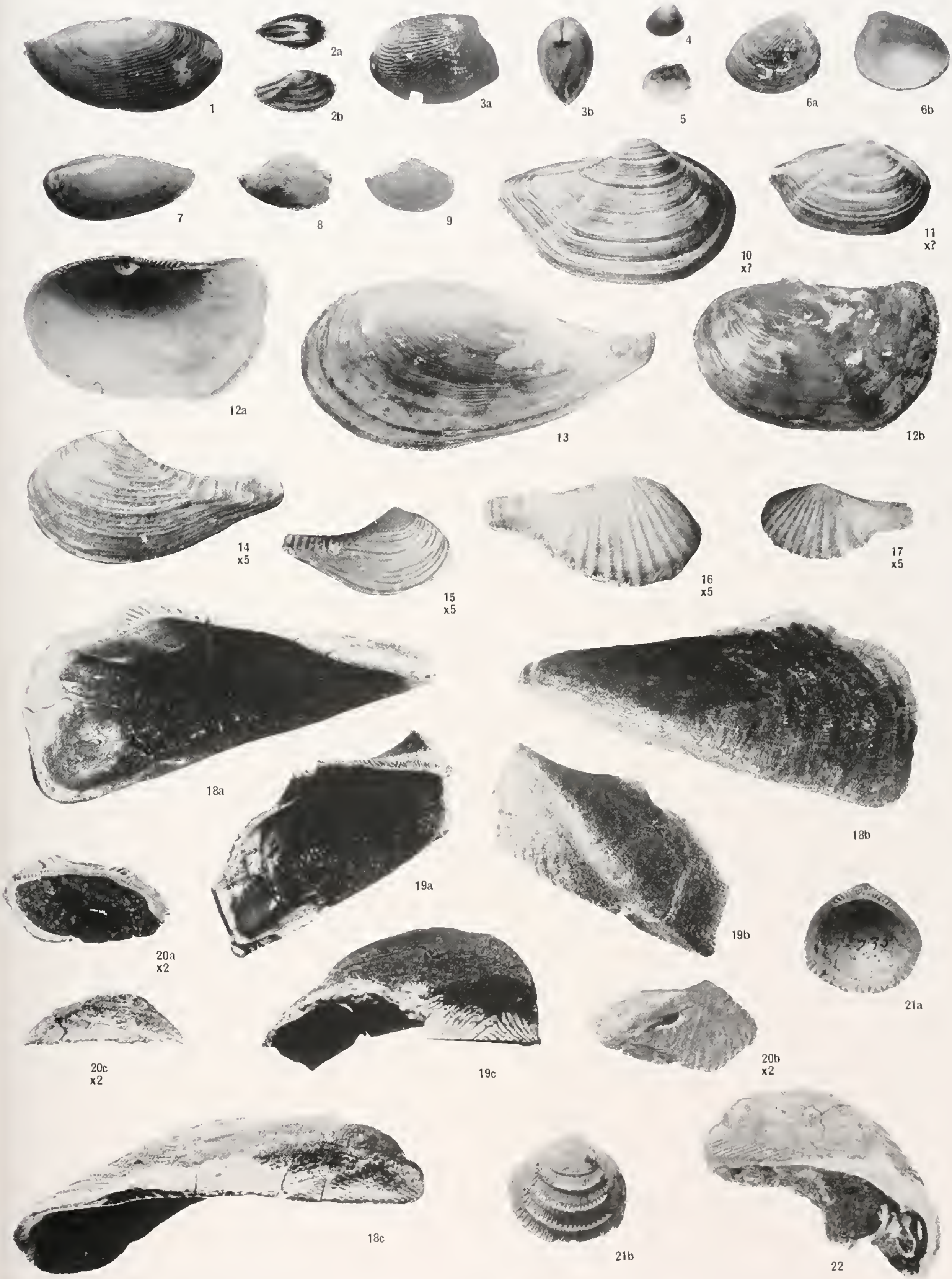
FIG. 13. *Yoldia cooperi* Gabb, Recent specimen from Halfmoon Bay, middle California, labeled 19-2A in the collection at Stanford University. Exterior of the left valve, length 64 mm. (See also plate 14, fig. 3, for view of the interior.) This species is the type of the new section *Kalayoldia* . . . . page 128

FIG. 14. *Nuculana hamata* (Carpenter), Recent specimen from San Pedro, in box labeled 14A in the collection at Stanford University. Exterior of left valve, × 5, length 9 mm . . . . page 125

FIG. 15. *Nuculana hamata* (Carpenter), another specimen from the same lot as the last. Exterior of right valve, × 5, length 6 mm . . . . page 125

FIG. 16. *Cuspidaria* (*Cardiomya*) *pectinata* (Carpenter), Recent specimen from San Pedro, in box labeled 33A in the collection at Stanford University. Exterior of right valve, × 5, length 7.8 mm. This species is shown here although it belongs with the *Thraciidæ* to illustrate the similarity of its shape with that of *Nuculana hamata*. Although it lacks the small taxodont teeth of the latter, which it may once have had and lost, several features suggest that it should not be placed in a different order . . . . page 265

(*Continued on page 883*)


1
2a
2b
3a
3b
4
5
6a
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8
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x?
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12b
14
x5
15
x5
16
x5
17
x5
18a
18b
19a
19b
20a
x2
21a
20c
x2
19c
20b
x2
18c
21b
22

EXPLANATION OF PLATE 1—(Continued)

FIG. 17. *Cuspidaria (Cardiomya) pectinata* (Carpenter), another specimen from the same lot as the last. Exterior of left valve, × 5, length 5.3 mm............ .... page 265

FIGS. 18. *Arca (Navicula) terminumbonis*, new species, type, No. 79 S. D. S. N. H., from locality 207, basal Pliocene of Elsmere Canyon, Los Angeles Co. Left valve: fig. 18*a* of interior showing the teeth; fig. 18*b* of exterior showing shape and sculpture; fig. 18*c* of cardinal area showing the cardinal grooves and also part of the arch of the posterior margin under which there must have been a large byssal gape; length 75 mm .... page 142

FIGS. 19. *Arca (Navicula) terminumbonis*, new species, paratype, No. 80 S. D. S. N. H., from the same locality as the type. Left valve: figs. 19*a*, 19*b*, and 19*c* correspond in position to figs. 18*a*, 18*b*, and 18*c*, and show the variation in form of this species; partial length 51 mm.. page 142

FIGS. 20. *Arca (Navicula) terminumbonis*, new species, paratype, No. 81 S. D. S. N. H., from the same locality as the type. Right valve of young specimen: figs. 20*a*, 20*b*, and 20*c* correspond in position to the figures *a*, *b*, and *c* of the other specimens; × 2, maximum length 15 mm.. page 142

FIGS. 21. *Glycymeris septentrionalis* (Middendorff), specimen No. 84 S. D. S. N. H., from locality 233, lower Pleistocene north of Arroyo Santa Rosa, Ventura Co. Left valve: fig. 21*a*, interior showing hinge, etc.; fig. 21*b*, exterior showing one characteristic form produced by weathering; length 21 mm. It will be noticed that the normal sculpture of the shell remains on the side margins where it consists of broad, low ribs separated by narrow, shallow grooves; and the concentric rings are weak. The weathered part has stronger concentric rings (in this specimen), and each rib becomes two sharp knife-edges.. .... page 134

FIG. 22. *Arca (Navicula) terminumbonis*, new species, paratype, No. 82 S. D. S. N. H., from locality 202, basal Pliocene of Elsmere Canyon, Los Angeles Co. Cardinal area of right valve, length of hinge 39 mm., maximum dimension of shell 47 mm.. .... page 142

EXPLANATION OF PLATE 2

FIG. 1. *Arca (Arca) trilineata* Conrad, depressed variety, specimen No. 434 in the collection at Stanford University, from Shuman's Cut, Santa Barbara Co., Pliocene. Right valve, length 57 mm. This form occurs in a number of places in the Pliocene of California, but it is probably not of particular significance . . . . page 139

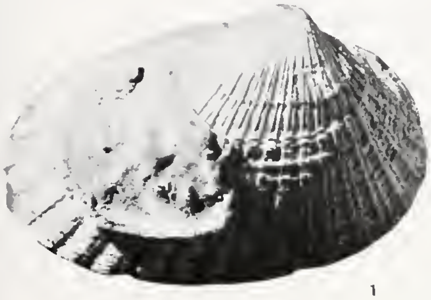
FIG. 2. *Pecten (Janira) bellus* (Conrad), variety close to *coalingaënsis* Arnold in F. M. Anderson, specimen No. 86 S. D. S. N. H., from locality 228, middle Pliocene southeast of Pico Canyon, Los Angeles Co. Right valve, length and altitude 31 mm., convexity 8 mm . . . . page 227

FIG. 3. *Pecten (Janira) bellus* (Conrad) variety *slevini* Dall and Ochsner, specimen No. 87 S. D. S. N. H., from locality 258, middle Pliocene (oyster-bed facies) north of the Santa Clara Valley and east of San Martinez Chiquito Canyon, Los Angeles Co. Right valve, length 65 mm., altitude 47 mm., convexity 17 mm. The unusual length of this form is not due to the crack in the middle, for other specimens without the crack have the same outline . . . . . . page 227

FIG. 4. *Arca (Arca) trilineata* Conrad, specimen No. 435 in the collection at Stanford University, from the basal Pliocene of Elsmere Canyon, Los Angeles Co. Left valve, length 47 mm . . . . page 139

FIGS. 5. *Arca (Arca) multicostata* Sowerby variety *camuloensis* Osmont, specimen No. 85 S. D. S. N. H., from locality 228, middle Pliocene southeast of Pico Canyon, Los Angeles Co. Right valve of an unusually large, gerontic individual: fig. *5a*, view of back; fig. *5b*, view of cardinal area; fig. *5c*, view of anterior end; all $\times {}^2/_3$, altitude 102 mm., length 95 mm., convexity 54 mm. Such a form as this might easily be mistaken for a new species . . . . page 139

FIGS. 6. *Arca (Arca) trilineata* Conrad variety *calcarea*, new variety, type, specimen No. 436 in the collection at Stanford University, from the San Diego well, middle Pliocene. Left valve: fig. *6a*, interior showing the many cardinal grooves and the ponderosity of the shell; fig. *6b*, exterior view; length 80 mm. This variety appears to be characteristic of the middle Pliocene of the Santa Clara Valley region as well as of San Diego. It is analogous to the variety *camuloensis* of *Arca multicostata* . . . . page 140



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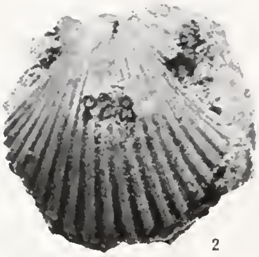

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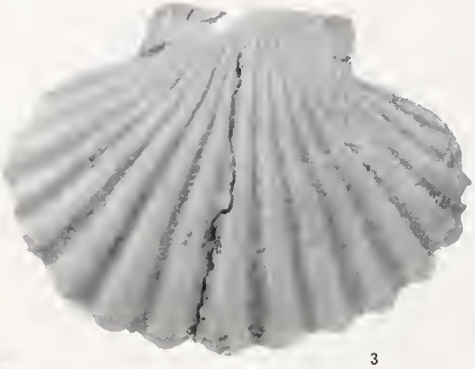

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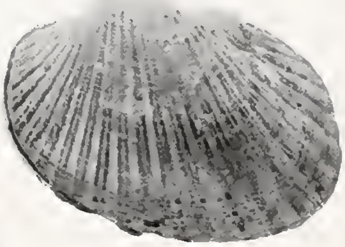

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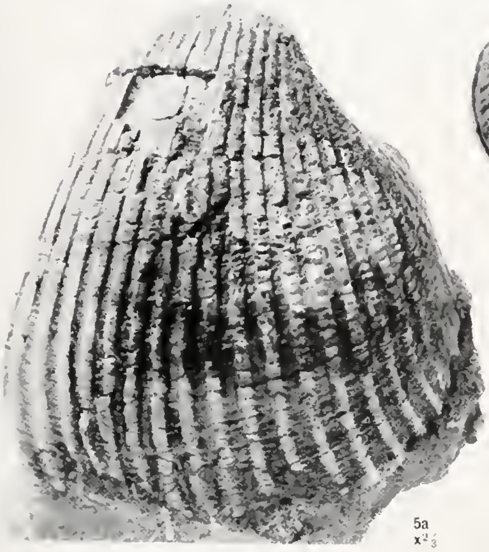

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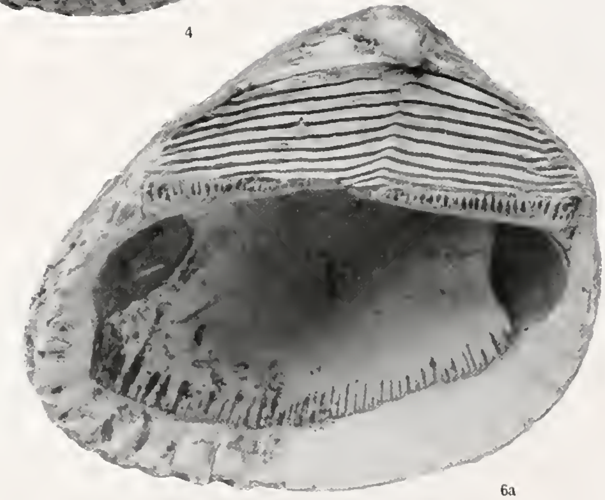
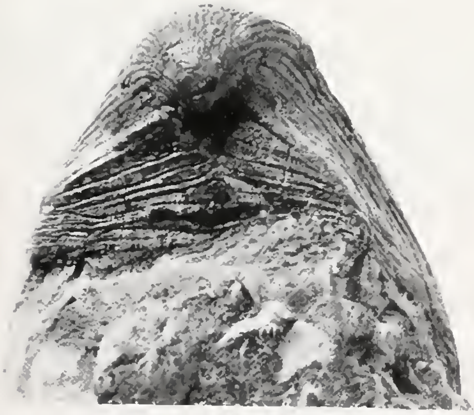


6a



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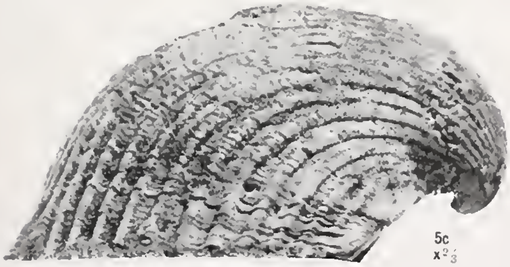

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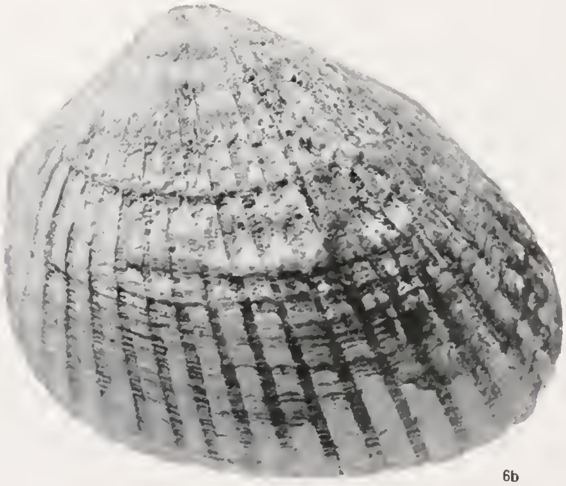


6b

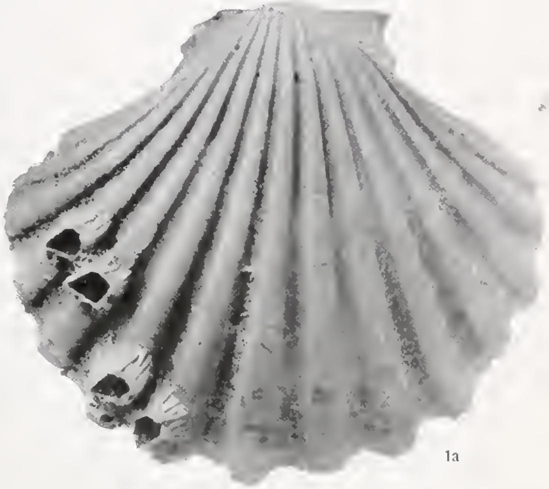
EXPLANATION OF PLATE 3

FIGS. 1. *Pecten (Janira) bellus* (Conrad) variety *hemphilli* Dall, specimen No. 88 S. D. S. N. H., from locality 100, middle Pliocene at Pacific Beach, San Diego. Fig. 1*a*, exterior of right valve; fig. 1*b*, exterior of left valve; length 75 mm., convexity of right valve 17 mm., left valve flat. This variety is practically indistinguishable from the typical variety............ page 226

FIGS. 2. *Pecten (Janira) stearnsii* Dall, typical variety, specimen No. 90 S. D. S. N. H., from locality 217*a*, middle Pliocene of Holser Canyon, Los Angeles Co. Right valve: fig. 2*a*, umbonal view showing the high, narrow ribs; fig. 2*b*, view looking straight down at it; length 71 mm., convexity 15 mm.. page 223

FIGS. 3. *Pecten (Janira) vogdesi* Arnold, Recent specimen from the Gulf of California, labeled 1588A in the collection at Stanford University. Fig. 3*a*, exterior of right valve; fig. 3*b*, exterior of left valve; length 62 mm., convexity of right valve 22 mm., concavity of left valve 5 mm.. page 228

FIG. 4. *Pecten (Janira) stearnsii* Dall variety *diegensis* Dall, specimen No. 89 S. D. S. N. H., from locality 226, middle or lower Pliocene near the mouth of Smith Canyon (first canyon east of Torrey Canyon) south of the Santa Clara Valley, Ventura Co. Right valve, length 80 mm., convexity 11 mm. This form is somewhat intermediate between *bellus* and *stearnsii*, but the depressed form and number of ribs clearly relate it to the variety *diegensis* of the latter.. page 223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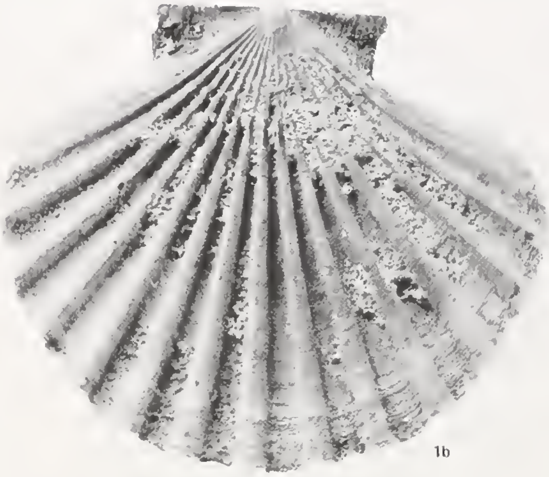
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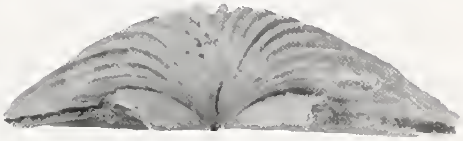
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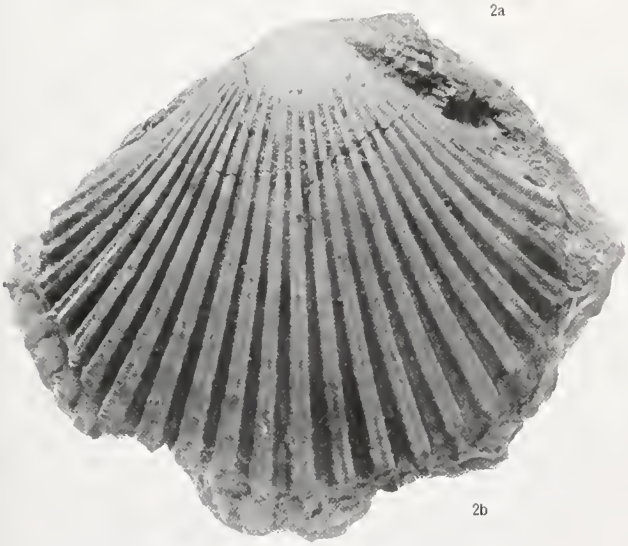
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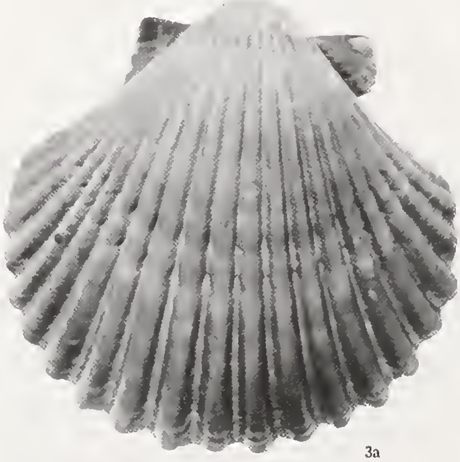
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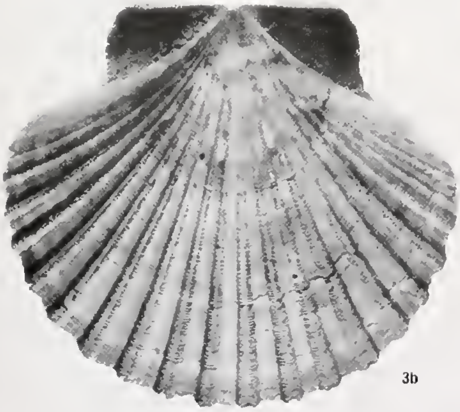
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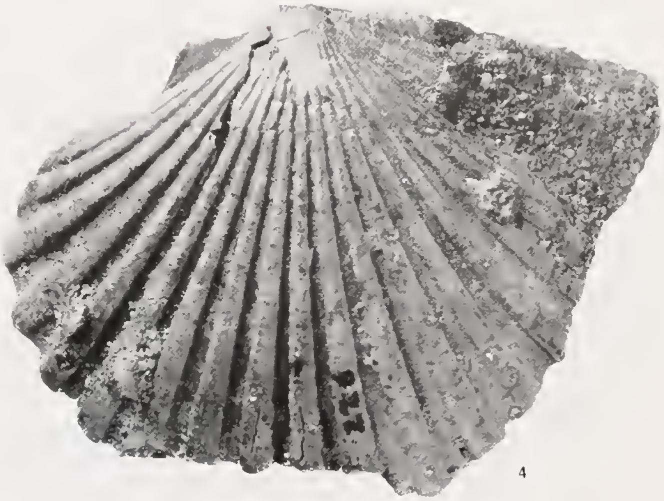
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EXPLANATION OF PLATE 4

FIGS. 1. *Pecten (Janira) stearnsii* Dall variety *bakeri* Hanna and Hertlein, plesiotype, No. 91 S. D. S. N. H., from locality 32, Santa Rosalia, Lower California, probably Pliocene. Fig. 1*a*, right valve; fig. 1*b*, left valve; altitude 112 mm. . . . . page 224

FIGS. 2. *Pecten (Aequipecten) purpuratus* Lamarck, Recent specimen from Coquimbo, Chile, No. 437 in the collection at Stanford University. Fig. 2*a*, right valve; fig. 2*b*, left valve; fig. 2*c*, umbonal view showing the relative convexity of the two valves (right valve below, in the natural position); length 77 mm. . . . . page 207

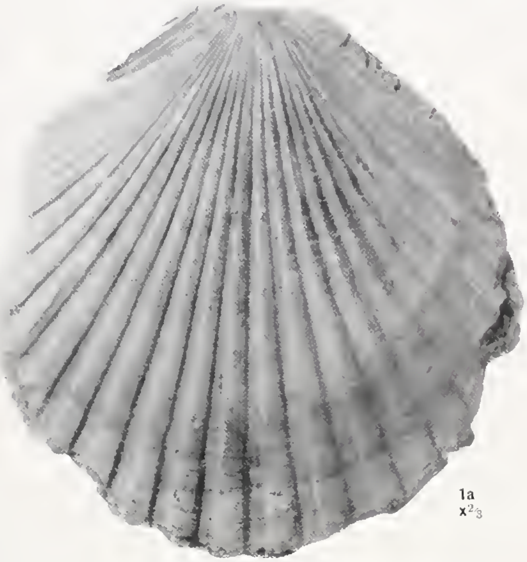
FIG. 3. *Pecten (Aequipecten) latiauratus* Conrad variety *monotimeris* Conrad, specimen No. 92 S. D. S. N. H., from locality 78, ½ mi. S. of Seacliff Sta. on the Southern Pacific R. R., Ventura Co., Pleistocene terrace. Exterior of right valve, length 28 mm . . . . page 204

FIG. 4. *Pecten (Aequipecten) andersoni* Arnold, specimen No. 93 S. D. S. N. H., from the middle Miocene of Barker's Ranch, Kern Co. Exterior of the right valve, length 24 mm. This species is difficult to distinguish from the typical variety of *latiauratus* on the one hand and from *discus* on the other. . . . . page 202

FIG. 5. *Pecten (Aequipecten) andersoni* Arnold, specimen No. 94 S. D. S. N. H., from the same locality as the last. Exterior of the right valve, length 40 mm . . . . page 202

FIG. 6. *Pecten (Aequipecten) latiauratus* Conrad variety *monotimeris* Conrad, Recent specimen from San Diego, No. 95 S. D. S. N. H. Exterior of right valve, length 34 mm. . . . . page 204

FIG. 7. *Pecten (Aequipecten) discus* Conrad, specimen No. 96 S. D. S. N. H., from the Santa Margarita formation, upper Miocene, from a depth of 4655 feet in the Superior Oil Company's well, Ansolabehere No. 1, northwest of Bakersfield, Kern Co. Exterior of right valve, altitude 47 mm. This species is doubtfully distinguishable from *Pecten opercularis* (Linnæus), the type of *Aequipecten*. . . . . page 200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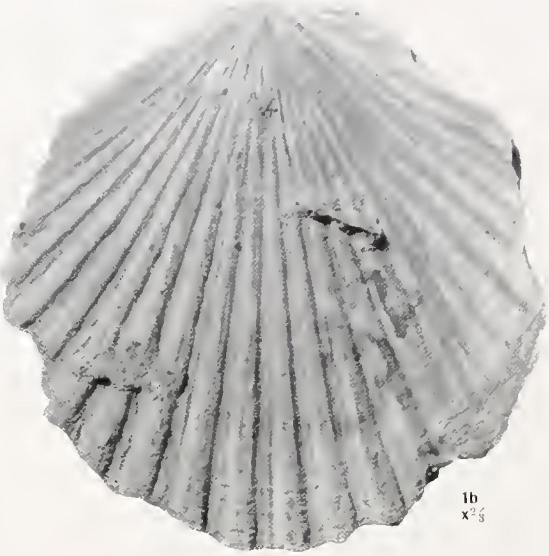
x 2/3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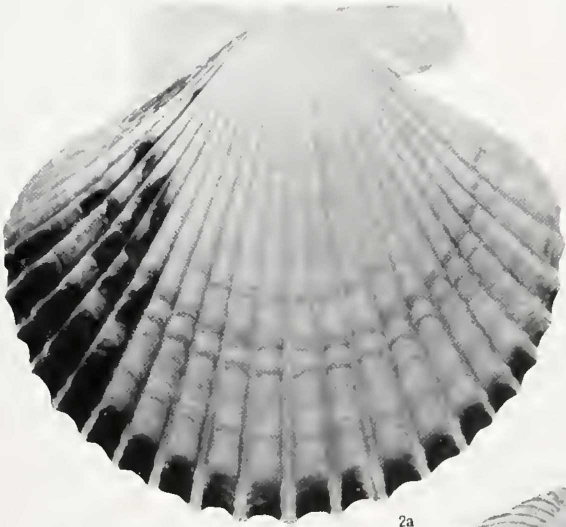
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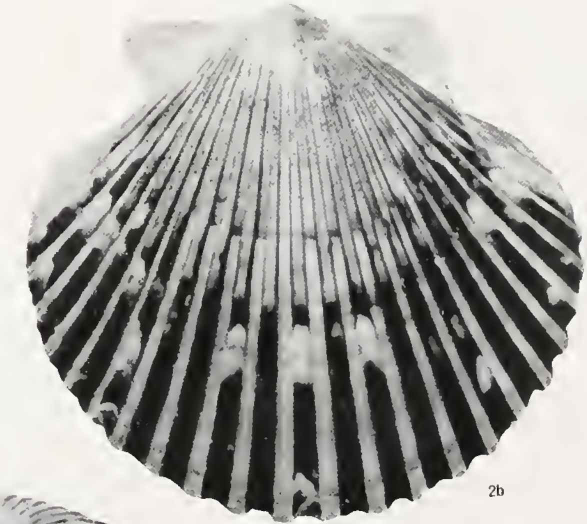
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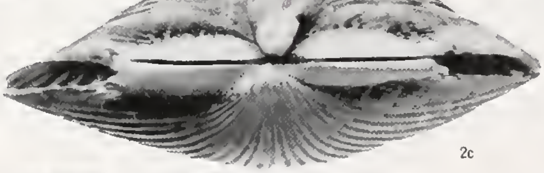
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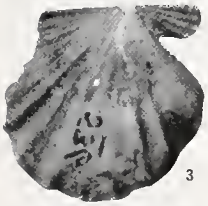
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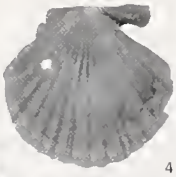
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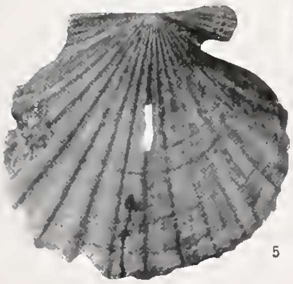
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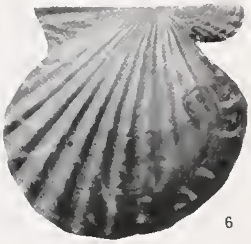
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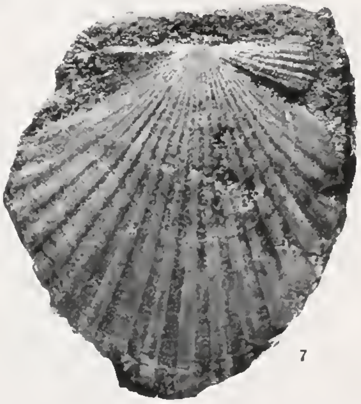
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EXPLANATION OF PLATE 5

Fig. 1. *Pecten (Aequipecten) purpuratus* Lamarck variety *subdolus* Hertlein, specimen No. 97 S. D. S. N. H., from the middle Pliocene of locality 214, west of Fernando Pass, Los Angeles Co. Exterior of right valve, length 52 mm. The unusual width of the ribs on this specimen may be partly due to erosion.. page 211

Fig. 2. *Pecten (Aequipecten) purpuratus* Lamarck variety *cristobalensis* Hertlein, type, specimen No. 36 in the collection at Stanford University, from 3 mi. south of Turtle Bay, Lower California, Pliocene. Exterior of right valve, length 135 mm. This specimen is intermediate between the most characteristic forms of *cristobalensis* and the variety *bakei*. A small specimen would be like *callidus*.. page 210

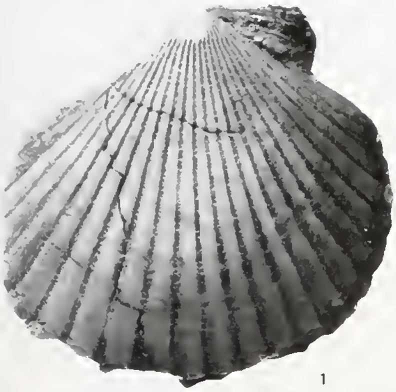
Fig. 3. *Pecten (Aequipecten) deserti* Conrad, type variety, specimen No. 98 S. D. S. N. H., from the (middle ?) Pliocene of the Carrizo Creek beds, Imperial Co. Exterior of right valve, length 35 mm.. page 212

Fig. 4. *Pecten (Aequipecten) purpuratus* Lamarck variety *callidus* Hertlein, specimen No. 99 S. D. S. N. H., from the middle Pliocene of locality 212, west of Fernando Pass, Los Angeles Co. Exterior of right valve, 52 mm.. page 211

Figs. 5. *Pecten (Aequipecten) deserti* Conrad variety *invalidus* Hanna, specimen No. 100 S. D. S. N. H., from the middle Pliocene of locality 217*b*, Holser Canyon, Los Angeles Co. Fig. 5*a*, exterior of right valve; fig. 5*b*, umbonal view showing the equal convexity of the valves (right valve below); fig. 5*c*, exterior of left valve; length 39 mm., altitude 40 mm., convexity of the two valves 18 mm.. page 213

Figs. 6. *Pecten (Aequipecten) deserti* Conrad variety *invalidus* Hanna, variation leaning toward *Pecten gibbus*, perhaps should be called *Pecten gibbus* variety, specimen No. 101 S. D. S. N. H., from the same locality as the last. Fig. 6*a*, exterior of right valve; fig. 6*b*, side view (right valve below); fig. 6*c*, exterior of left valve; length 39 mm., altitude 37 mm., convexity of the two valves 20 mm. This form is more convex and more circular in outline than the normal specimens of *deserti*. It has the form of *ericellus* Hertlein..................... page 213

Figs. 7. *Pecten (Aequipecten) gibbus* (Linnæus) variety *circularis* Sowerby, Recent specimen from San Diego, labeled 1587A in the collection at Stanford University. Fig. 7*a*, exterior of right valve; fig. 7*b*, umbonal view showing the greater convexity of the right valve; fig. 7*c*, exterior of left valve showing, among other things, the one white rib characteristic of *Pecten gibbus;* length 46 mm., altitude 44 mm., convexity of the two valves, 27 mm.... page 218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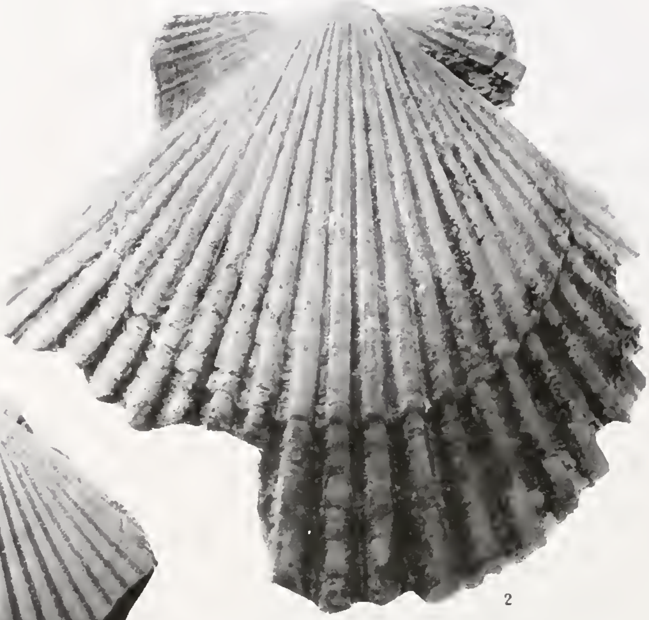
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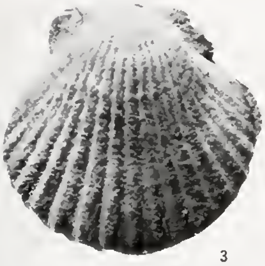
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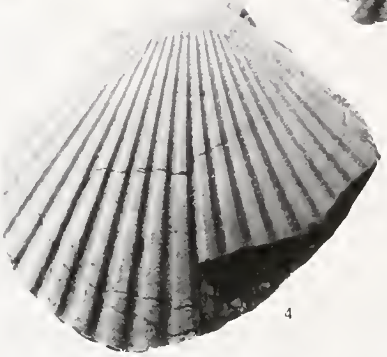
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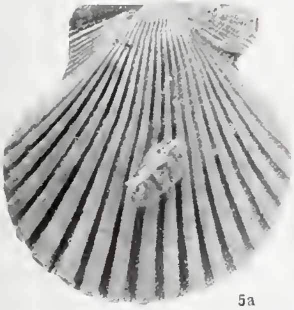
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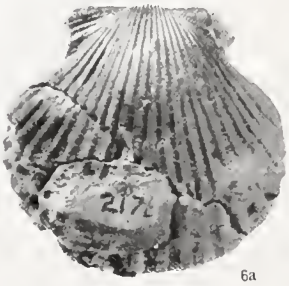
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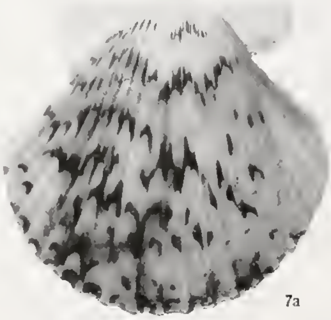
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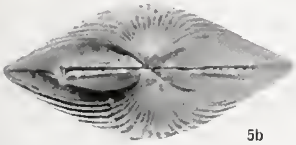
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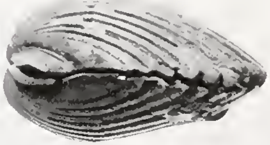
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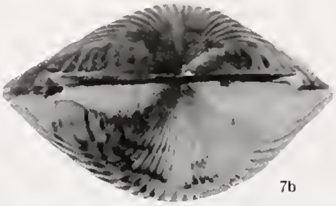
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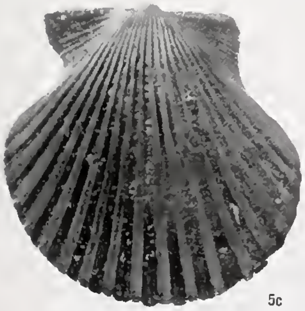
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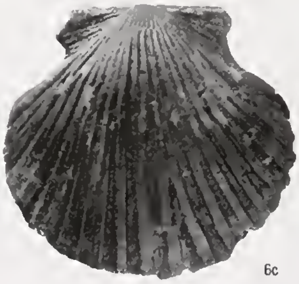
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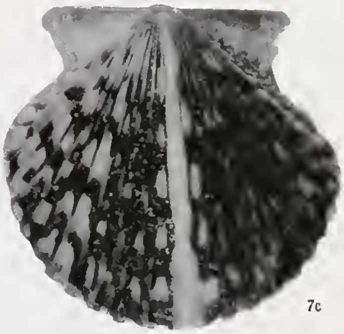
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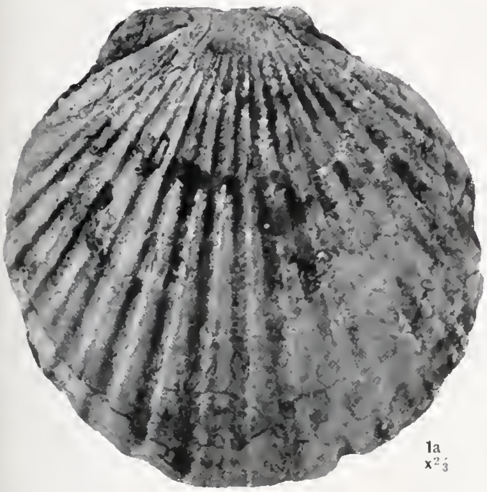
EXPLANATION OF PLATE 6

FIGS. 1. *Pecten (Patinopecten) healeyi* Arnold variety *lohri* Hertlein, specimen No. 102 S. D. S. N. H., from the basal Pliocene of locality 209, Elsmere Canyon, Los Angeles Co. Fig. 1*a*, exterior of right valve; fig. 1*b*, exterior of left valve; both figures × ⅔; length 98 mm. This is the ancestral variety of the species.. page 197

FIGS. 2. *Pecten (Patinopecten) healeyi* Arnold, typical variety, specimen No. 103 S. D. S. N. H., from the middle Pliocene of locality 100, Pacific Beach, San Diego. Fig. 2*a*, exterior of right valve with left valve showing behind; fig. 2*b*, exterior of left valve; a small specimen, length 85 mm.. .... page 196

FIG. 3. *Pecten (Patinopecten) purisimaensis* Arnold, specimen No. 104 S. D. S. N. H., from the Purisima formation, lower Pliocene, of locality 103 near the mouth of San Gregorio Creek, San Mateo Co., middle California. Exterior of right valve, × ⅔, altitude 128 mm........ page 194

FIG. 4. *Pecten (Patinopecten) caurinus* Gould, specimen No. 105 S. D. S. N. H., from the upper Pliocene of locality 225 between Timber Canyon and Santa Paula Creek, Ventura Co. Exterior of right valve, somewhat distorted, × ⅔, length about 140 mm., altitude 123 mm., convexity 20 mm., the left valve nearly flat. This species is very common in this and nearby localities of the same horizon, but it is difficult to get a complete specimen................. page 194



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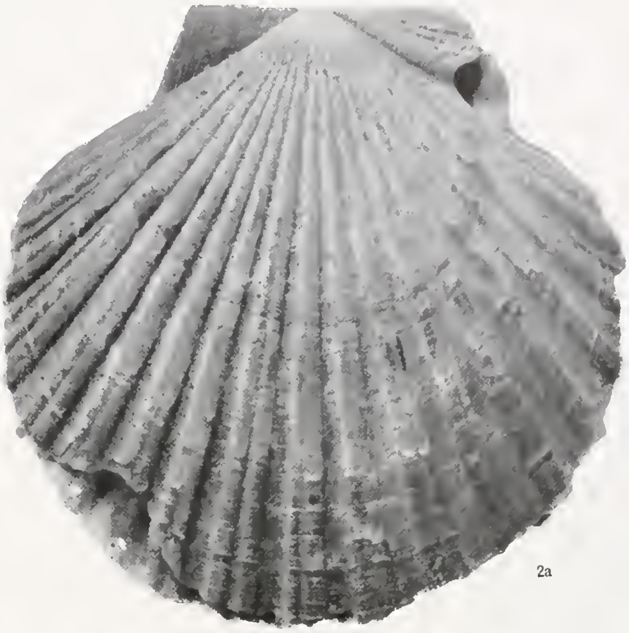

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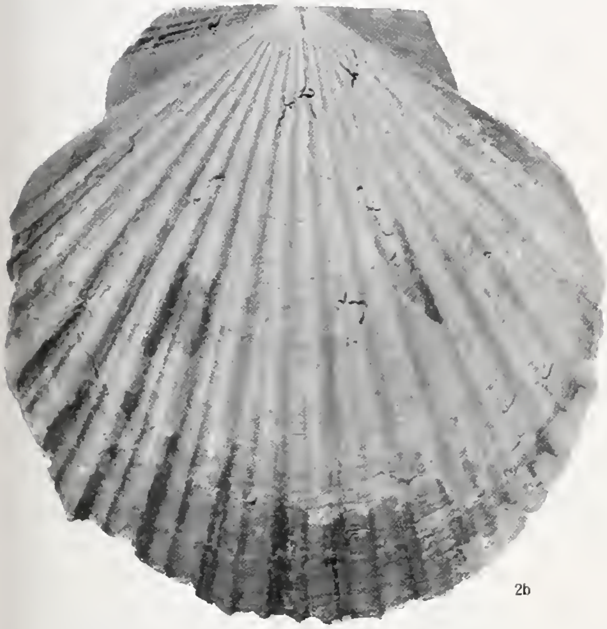

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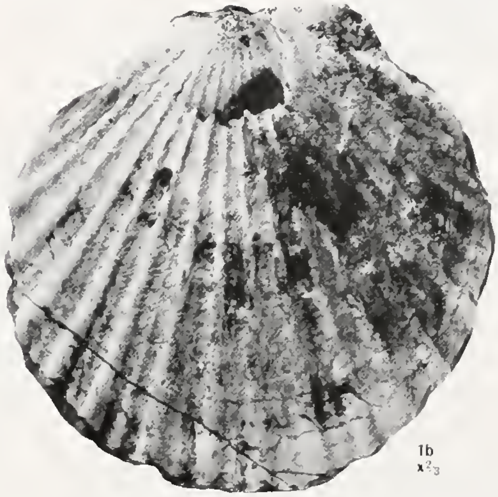
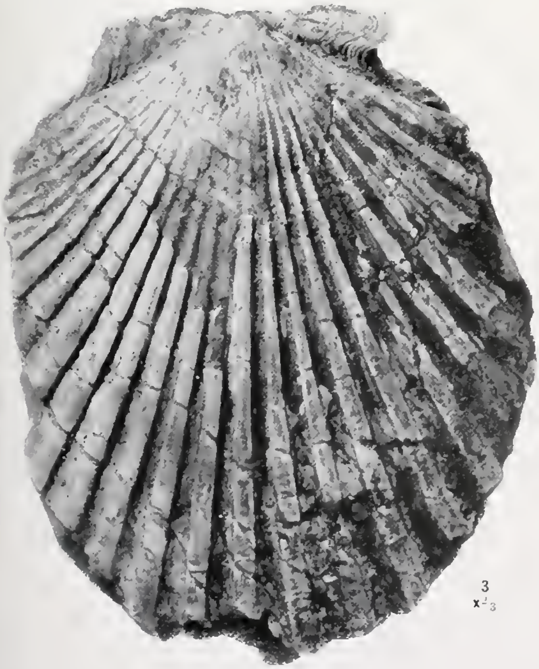
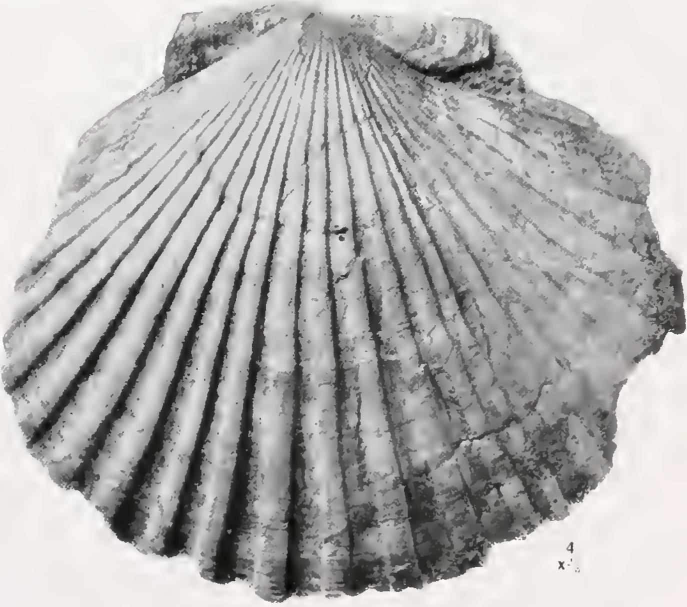


1b
x⅔



3
x⅔

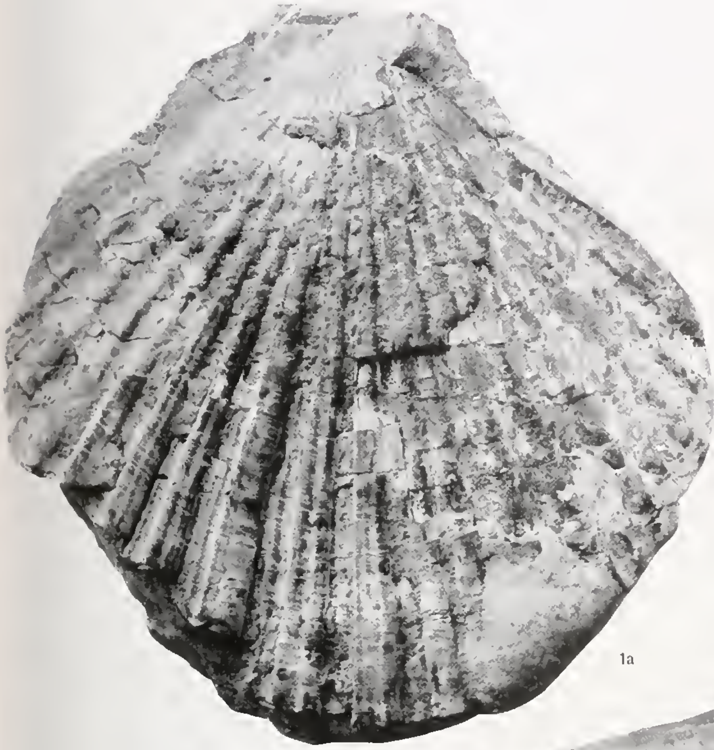


4
x⅔

EXPLANATION OF PLATE 7

Figs. 1. *Pecten (Vertipecten) nevadanus* Conrad variety *fucanus* Dall, specimen No. 438 in the collection at Stanford University, labeled Miocene of Kern River. Fig. 1*a*, exterior of right valve, which is practically flat; fig. 1*b*, exterior of left valve; altitude 98 mm. . . . . page 190

Figs. 2. *Pecten (Vertipecten) nevadanus* Conrad, typical variety, neotype, specimen No. 431 in the collection at Stanford University, said to have come either from the McKittrick District or from the Santa Monica Mts., southern California, middle Miocene. Fig. 2*a*, exterior of right valve, which is not quite so flat as the right valve shown in fig. 1*a;* fig. 2*b*, exterior of left valve; fig. 2*c*, posterior profile; the three views approximately $^2/_5$ natural size, length 200 mm. This specimen is selected as the neotype because of its unusually fine state of preservation, even if the locality is somewhat in doubt. Fragmentary specimens from Conrad's locality show the same characters . . . . page 189



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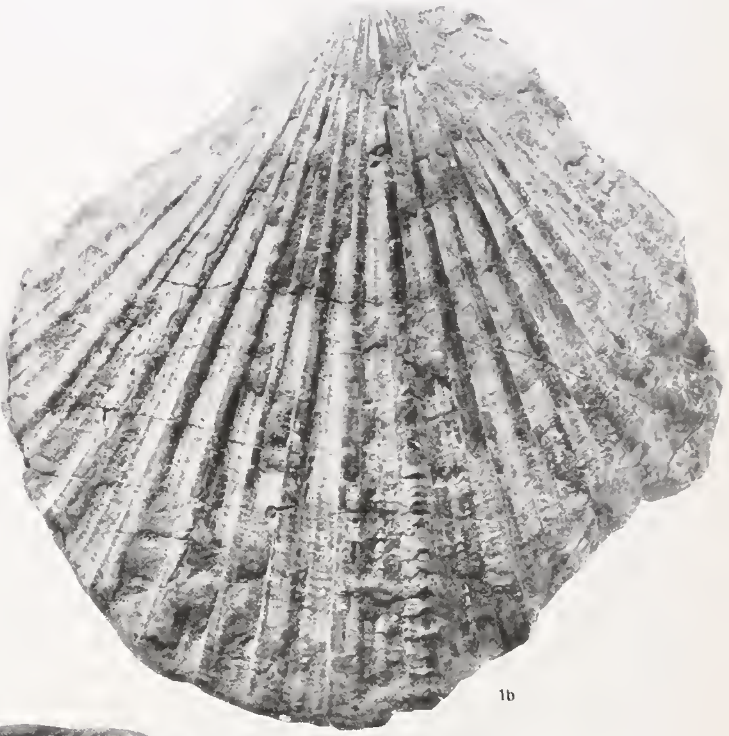
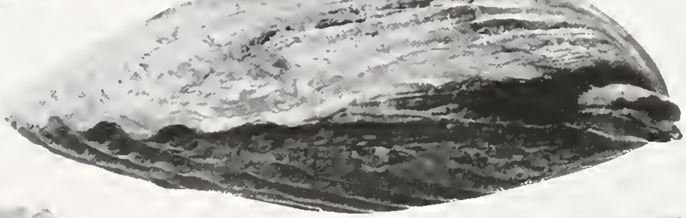


1b



2c
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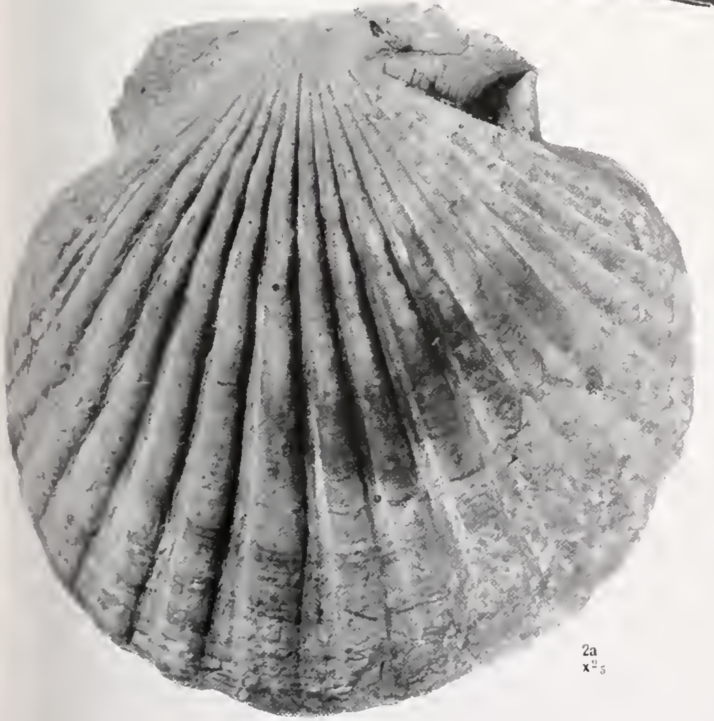
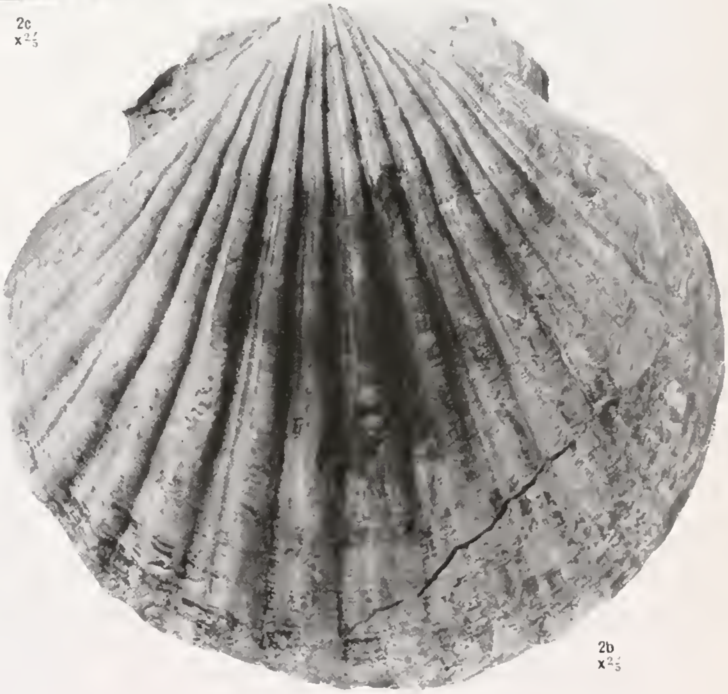


2a
x 2/5



2b
x 2/5

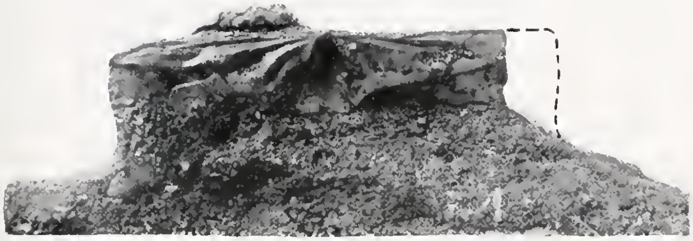
EXPLANATION OF PLATE 8

FIGS. 1. *Pecten* (*Lyropecten*) *estrellanus* (Conrad) variety *cerrosensis* Gabb, specimen No. 107 S. D. S. N. H., from the middle Pliocene of locality 228, southeast of Pico Canyon, Los Angeles Co. A large, humped-up, gerontic individual; fig. 1*a*, interior of the hinge showing the diverging grooves; fig. 1*b*, exterior of the same valve, the left valve; both views $\times \frac{2}{3}$, length 176 mm. . . . . page 187

FIGS. 2. *Pecten* (*Lyropecten*) *estrellanus* (Conrad) variety *cerrosensis* Gabb, specimen No. 108 S. D. S. N. H., from the middle Pliocene of locality 217*b*, Holser Canyon, Los Angeles Co. A small specimen showing faintly a differentiation of the ribs as in *P. nodosus;* fig. 2*a*, exterior of right valve; fig. 2*b*, exterior of left valve; both views $\times \frac{3}{4}$, length 79 mm. . . . . page 187

FIG. 3. *Pecten* (*Aequipecten*) *purpuratus* Lamarck variety *hakei* Hertlein, type, specimen No. 40 in the collection at Stanford University, from the Pliocene of Turtle Bay, Lower California. Exterior of right valve, $\times \frac{2}{3}$, length 135 mm. This variety is probably the same as *P. purpuratus* variety *cristobalensis* shown on plate 5, figure 2, but it is included here because it is likely to be mistaken for a *Lyropecten*. It is large and has an abnormally heavy, incrassated shell; but its lack of diverging grooves on the interior of the hinge, its longer hinge line, and its intergrading with the other varieties or variations of *P. purpuratus* with which it lives show it to be an *Aequipecten* . . . . page 209

FIG. 4. *Pecten* (*Lyropecten*) *estrellanus* Conrad, typical variety, specimen No. 106 S. D. S. N. H., from the basal Pliocene of locality 209, Elsmere Canyon, Los Angeles Co. Exterior of right valve, length approximately 115 mm., convexity of the right valve 20 mm. It is possible that this specimen should be referred to the variety *catalinæ* Arnold (specimens of which were found with it), but it is larger, coarser, and somewhat more convex . . . . page 185



1a
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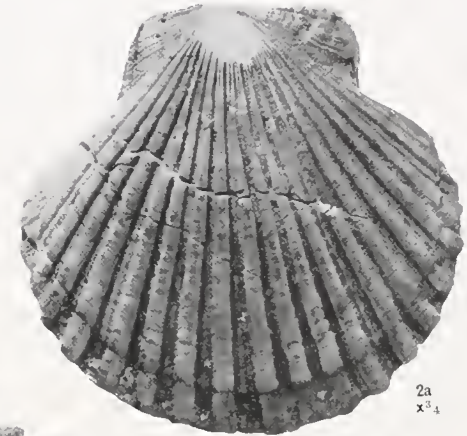
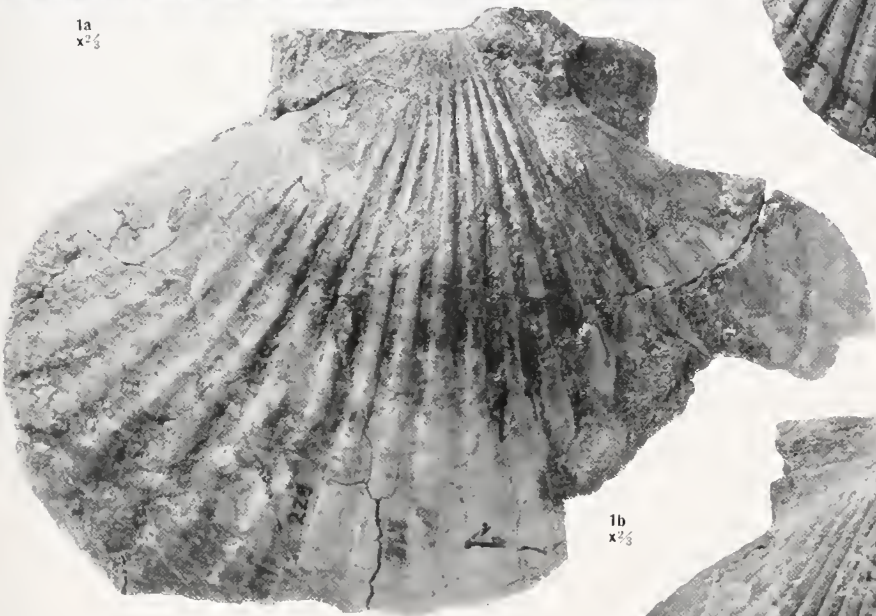
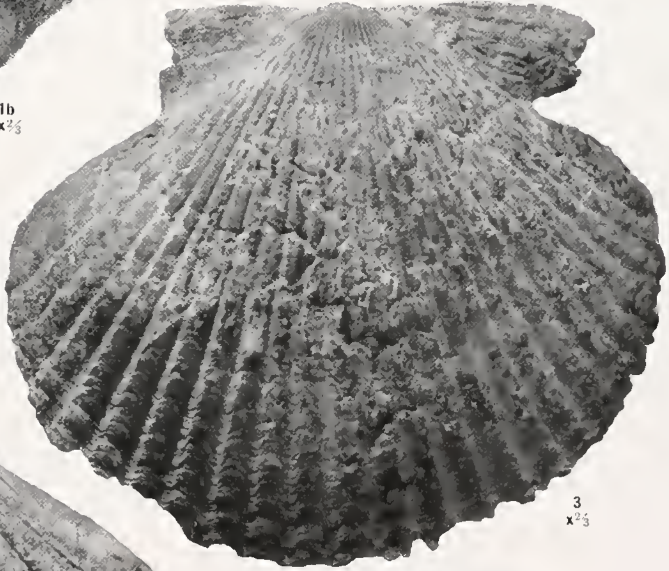


2a
x3/4



1b
x2/3



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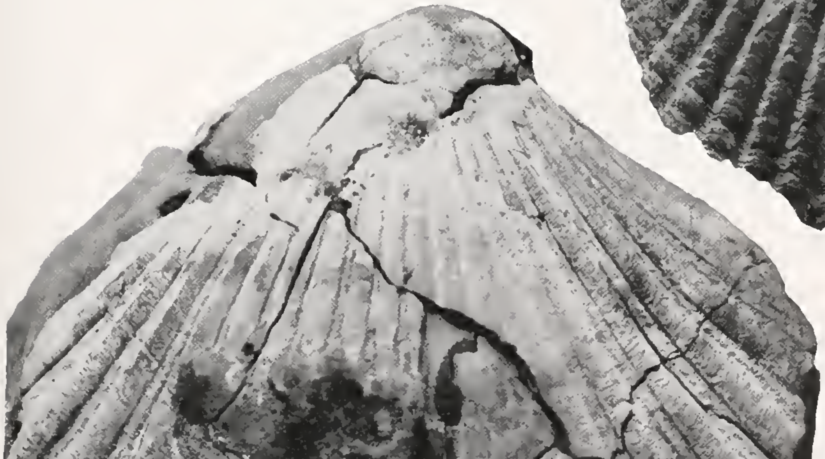
x2/3



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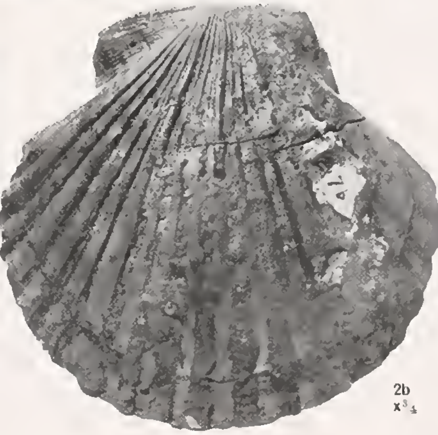


2b
x3/4

EXPLANATION OF PLATE 9

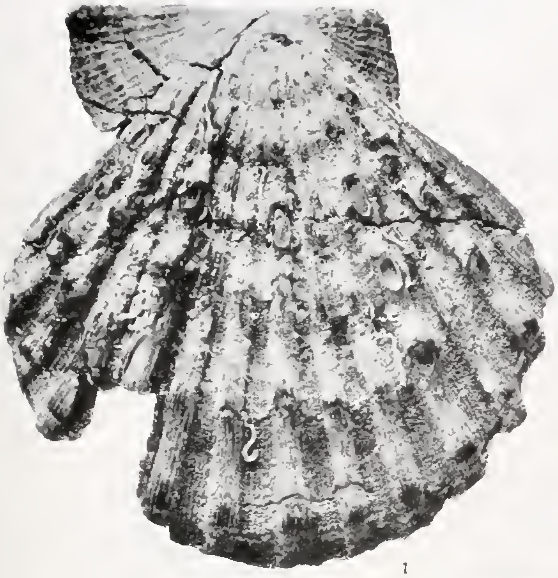
FIG. 1. *Pecten (Lyropecten) magnificus* Sowerby, typical variety, Recent specimen from the Galapagos Islands, No. 439 in the collection at Stanford University. Exterior of small left valve, length 78 mm. See also plate 10, figure 6 . . . . page 182

FIG. 2. *Pecten (Lyropecten) estrellanus* (Conrad) variety *cerrosensis* Gabb, specimen No. 109 S. D. S. N. H., from the middle Pliocene of locality 263 between Fernando Pass and Pico Canyon, Los Angeles Co. Exterior of right valve, $\times \frac{2}{3}$, length 127 mm. . . . . page 187

FIG. 3. *Pecten (Lyropecten) jeffersonius* Say, specimen No. 441 in the collection at Stanford University, from the Miocene of the Atlantic Coast. Exterior of right valve, $\times \frac{2}{3}$, length 147 mm . . page 176

FIG. 4. *Pecten (Lyropecten) magnificus* Sowerby variety *crassicardo* (Conrad), specimen No. 442 in the collection at Stanford University, from the Santa Margarita formation, upper Miocene, of Cammalta Ranch, San Luis Obispo Co., middle California. Exterior of the left valve showing a faint differentiation of the ribs, $\times \frac{2}{3}$, length and altitude 107 mm . . . . page 183

FIG. 5. *Pecten (Lyropecten) magnificus* Sowerby variety *crassicardo* (Conrad), specimen No. 443 in the collection at Stanford University, from the Santa Margarita formation, upper Miocene, probably of the Nipomo Quadrangle, San Luis Obispo Co. Exterior of the right valve showing a grouping of the ribs (rather unusual for this variety), $\times \frac{2}{3}$, length 111 mm . . . page 183



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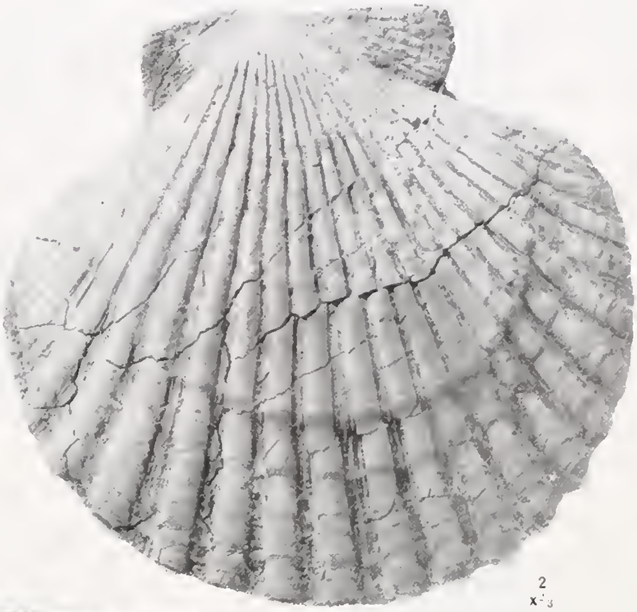

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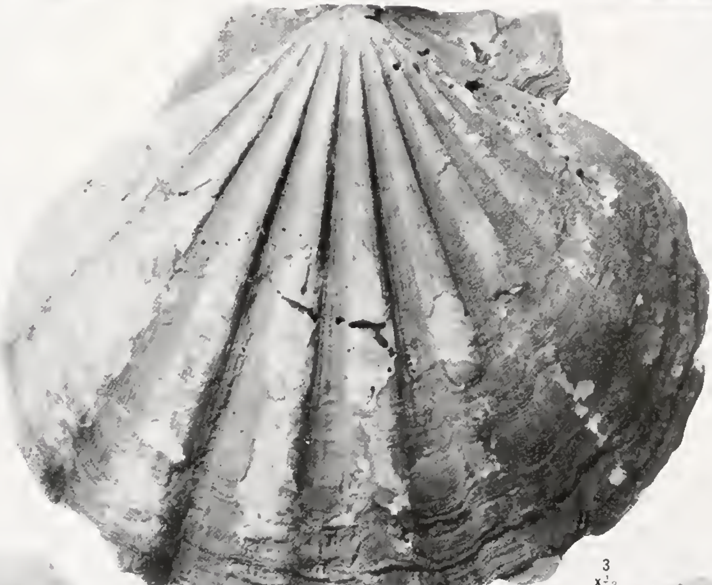

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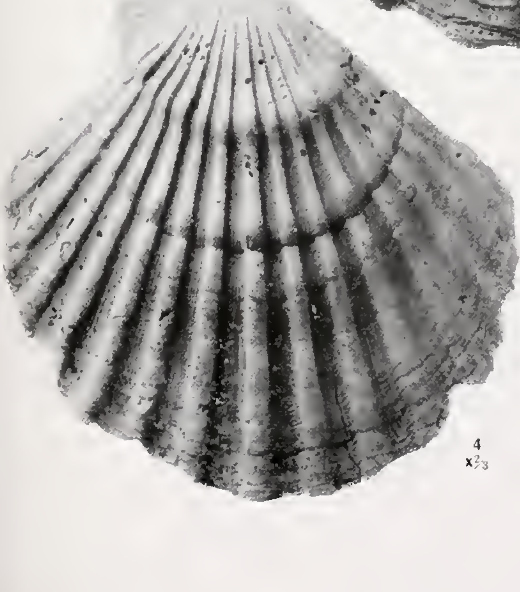

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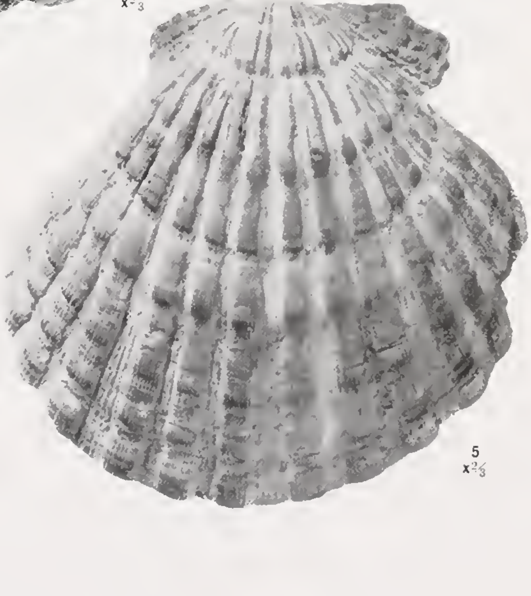


5
x2/3

EXPLANATION OF PLATE 10

FIGS. 1. *Pecten* (*Pallium*) *swiftii* Bernardi, reproduction of the original figures of the type specimen, Recent in Japan, from the Journal de Conchyliologie, Vol. 7, p. 90, pl. 1, fig. 1, pl. 2, fig. 1, 1858. Fig. 1*a*, exterior of the right valve; fig. 1*b*, exterior of the left valve; both illustrations reduced ½, altitude 105 mm., length 89 mm . . . . page 171

FIG. 2. *Pecten* (*Pallium*) *swiftii* Bernardi, form *parmeleei* Dall, specimen No. 110 S. D. S. N. H., from the middle Pliocene of locality 217*a*, Holser Canyon, Los Angeles Co. Exterior of right valve, altitude 59 mm., length 53 mm. This form is so close to the typical that it is hardly worth while to try to separate it . . . . page 171

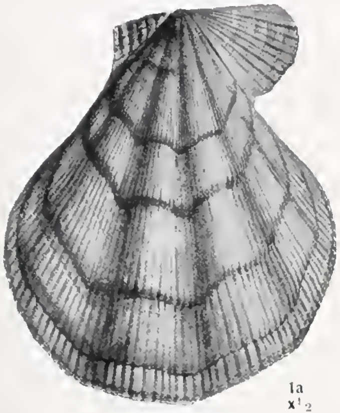
FIGS. 3. *Pecten* (*Pallium*) *swiftii* Bernardi, form *wattsi* Arnold, specimen No. 111 S. D. S. N. H., from the middle Pliocene of locality 217*a*, Holser Canyon, Los Angeles Co. Fig. 3*a*, exterior of right valve; fig. 3*b*, exterior of left valve; altitude 37 mm., length 32 mm. This form is merely a variation of the variety *etchegoini* . . . . page 173

FIGS. 4. *Pecten* (*Pallium*) *swiftii* Bernardi, Recent specimen from Notoro Bay, Hokkaido, Japan, No. 112 S. D. S. N. H. Fig. 4*a*, exterior of right valve; fig. 4*b*, exterior of left valve; both figures × ⅔, altitude 102 mm., length 88 mm. This species is a typical member of the section *Manupecten* . . . . page 171

FIG. 5. *Pecten* (*Pallium*) *swiftii* Bernardi, form *parmeleei* Dall, specimen No. 113 S. D. S. N. H., from the middle Pliocene of locality 217, Holser Canyon, Los Angeles Co. Exterior of right valve, altitude 43 mm., length 40 mm. Compare fig. 2 . . . . page 171

FIG. 6. *Pecten* (*Lyropecten*) *magnificus* Sowerby, typical variety, Recent specimen from the Galapagos Islands, No. 439 in the collection at Stanford University. Exterior of the right valve of a large specimen, reduced ½, length 174 mm. It will be noted that this specimen is more like the usual form of the variety *crassicardo* than are any of the specimens shown on plate 9 . . . . page 182

FIG. 7. *Pecten* (*Pallium*) *swiftii* Bernardi, form *kindlei* Dall, specimen No. 444 in the collection at Stanford University, from the Pliocene (or Pleistocene) of Nome, Alaska. Exterior of right valve, × ⅔, altitude 90 mm., length about 75 mm . . . . page 174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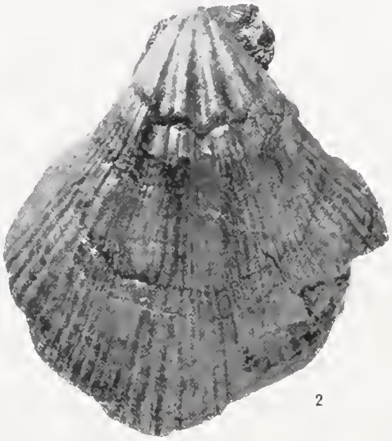
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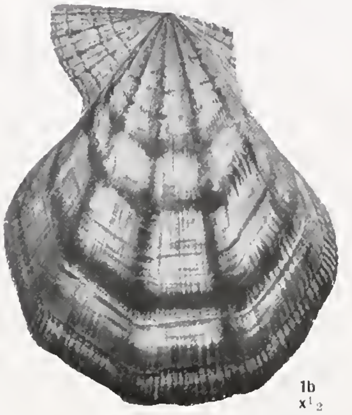
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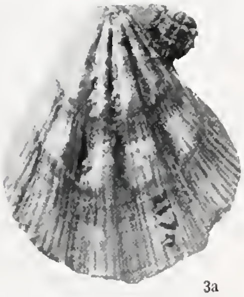
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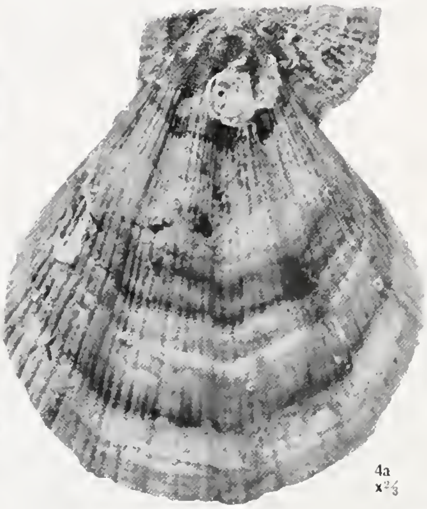
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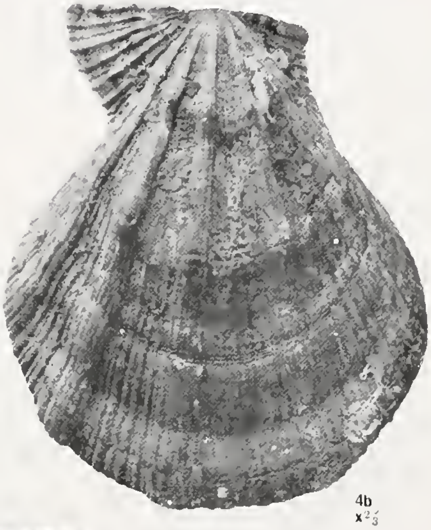
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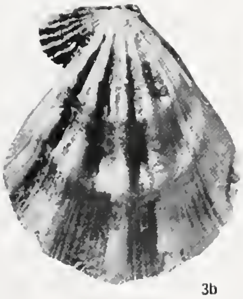
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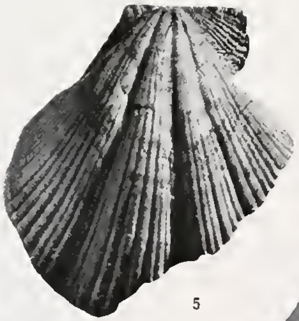
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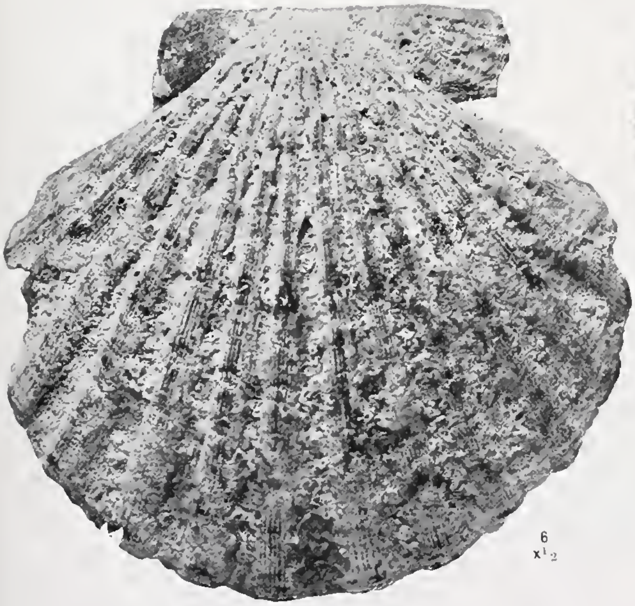
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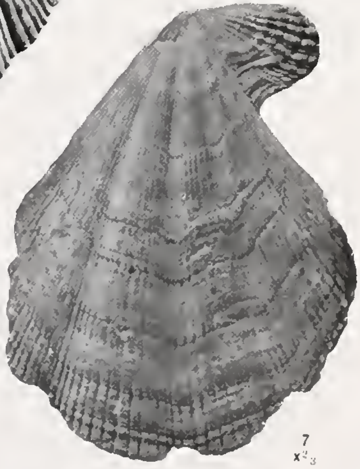
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EXPLANATION OF PLATE 11

FIGS. 1. *Pecten (Pecten) islandicus* Müller, Recent specimen from Eastport, Maine, labeled 1600A in the collection at Stanford University. Fig. 1*a*, exterior of right valve; fig. 1*b*, exterior of left valve; altitude 81 mm., length 74 mm. This form is identical with that found in the north Pacific.......... page 161

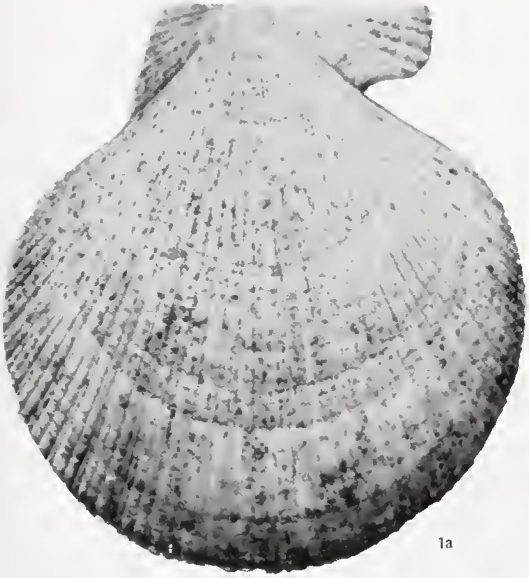
FIG. 2. *Pecten (Pecten) beringianus* Middendorff, specimen No. 114 S. D. S. N. H., from locality 218, upper Pliocene of Sulphur Canyon east of South Mt., Ventura Co. Exterior of left valve, altitude 23 mm., length 19 mm. This is a small specimen of a form that was originally described as a variety of *islandicus* and may even be a variety of *islandicus*. It illustrates how easy the transition may have been from forms like *Propeamussium* or *Pseudamussium* to *Chlamys*.......... page 165

FIG. 3. *Pecten (Pecten) opuntia* Dall, specimen No. 445 in the collection at Stanford University, from the Calabasas Quadrangle, Ventura or Los Angeles Co., probably middle Pliocene. Exterior of left valve, altitude 69 mm., length 67 mm. The sculpture on the other valve is practically the same. This form probably intergrades with the varieties of *islandicus*, but it seems to be better characterized.......... page 165

FIG. 4. *Pecten (Pecten) islandicus* Müller variety *jordani* Arnold, specimen No. 115 S. D. S. N. H., from the upper Pliocene of locality 39, Packard's Hill, Santa Barbara. Exterior of right valve, altitude 44 mm., length 42 mm. There is very little to distinguish this variety from a small specimen of the typical variety, and less to distinguish it from *hindsii*..... page 164

FIGS. 5. *Pecten (Pecten) multirugosus* Gale, young Recent specimen from San Pedro, labeled 103–1A in the collection at Stanford University. Fig. 5*a*, exterior of right valve; fig. 5*b*, exterior of left valve; altitude 27 mm. This specimen has just begun its sessile stage, which shows that it belongs to the typical section of *Pecten*, formerly called *Hinnites;* but it is almost obvious that it should be classified in the same subgenus as *Chlamys* and close to *P. hastatus*.......... page 159

FIGS. 6. *Pecten (Pecten) hastatus* Sowerby, specimen No. 447 in the collection at Stanford University, from the Simi Rancho, Ventura Co., probably lower Pleistocene. Fig. 6*a*, exterior of right valve; fig. 6*b*, exterior of left valve; altitude 55 mm., length 49 mm.......... page 166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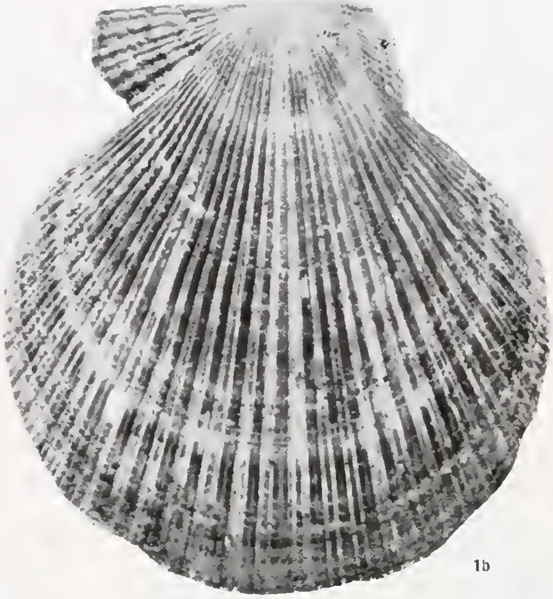
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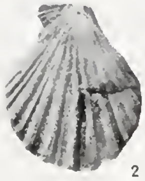
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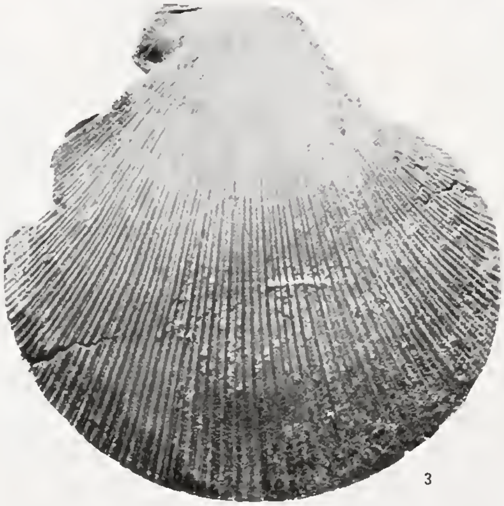
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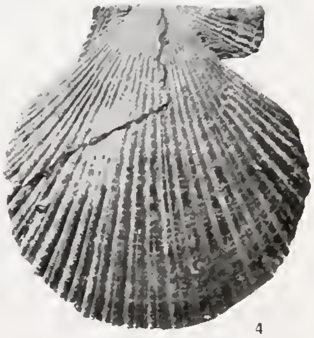
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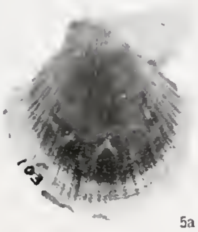

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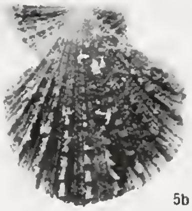
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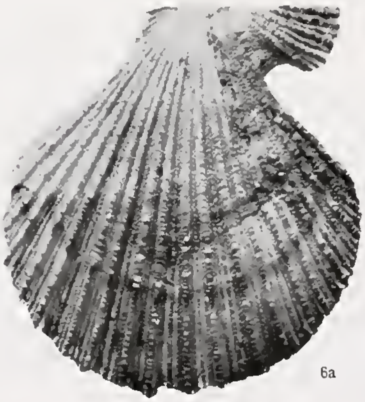
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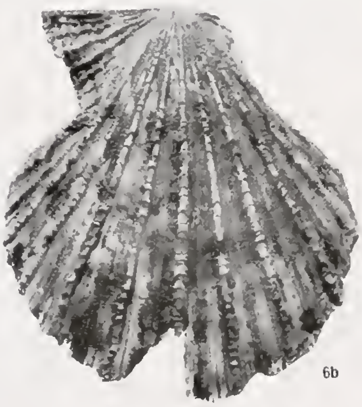
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EXPLANATION OF PLATE 12

FIGS. 1. *Ostrea vespertina* Conrad, normal variety, specimen No. 116 S. D. S. N. H., from locality 217*a*, middle Pliocene of Holser Canyon, Los Angeles Co. Fig. 1*a*, interior view showing hinge and muscle scar; fig. 1*b*, exterior of the same valve; altitude (greatest dimension) 76 mm. . page 152

FIG. 2. *Anomia peruviana* d'Orbigny, specimen No. 118 S. D. S. N. H., from locality 99, upper Pleistocene terrace west of Newport, Los Angeles Co. Exterior of upper valve (the left valve), greatest dimension 40 mm. . . . page 240

FIG. 3. *Pododesmus macroschisma* (Deshayes), specimen No. 120 S. D. S. N. H., from locality 217, middle Pliocene of Holser Canyon, Los Angeles Co. Exterior of upper valve showing sculpture, greatest dimension 43 mm. . . . page 241

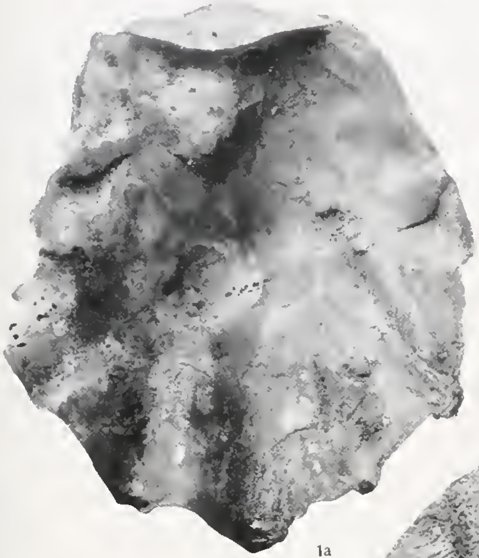
FIGS. 4. *Pododesmus macroschisma* (Deshayes), specimen No. 446 in the collection at Stanford University, from the upper San Pedro, upper Pleistocene, of Deadman Island, San Pedro Harbor, Los Angeles Co. Upper valve: fig. 4*a*, exterior showing sculpture; fig. 4*b*, interior showing the *two* muscle scars (one adductor and one byssal); both views × ½, length 100 mm. . . . page 241

FIG. 5. *Anomia peruviana* d'Orbigny, Recent specimen from the Gulf of California, in the collection at Stanford University, labeled 394–IA. Interior of the upper valve showing the *three* muscle scars (one adductor and two byssal), length 35 mm. . . . page 240

FIG. 6. *Mytilus* (*Mytilus*) *californianus* Conrad, Recent specimen from Seven Mile Beach, San Mateo Co., middle California, No. 117 S. D. S. N. H. Exterior, length 127 mm. . . . page 245

FIG. 7. *Volsella recta* (Conrad), form *flabellata* (Gould), specimen No. 448 in the collection at Stanford University, from the Merced Pliocene at Capitola, Santa Cruz Co., middle California Exterior of right valve, length 128 mm. . . . page 250

FIG. 8. *Modiolaria lævigata* (Gray), Recent specimen taken off San Juan Island, Puget Sound, No. 119 S. D. S. N. H. Exterior of left valve, length 26 mm. This species is distinguished from *nigra* (Gray) by the lack of radial striations on most of its surface. It is, like *discors* (Linnaeus), divided into three radial compartments; but only the small anterior one is radially ribbed, whereas in *discors* the posterior one is also. The species *lævigata* was described at the same time as *nigra*, on the same page. Its type locality is Greenland. . . page 254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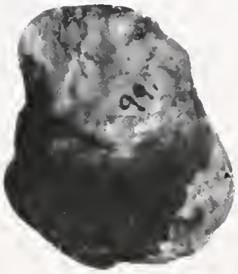
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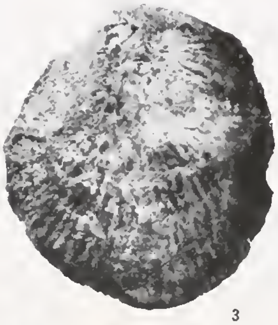
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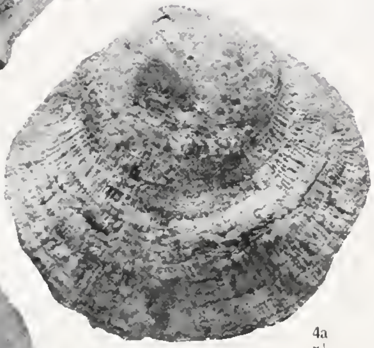
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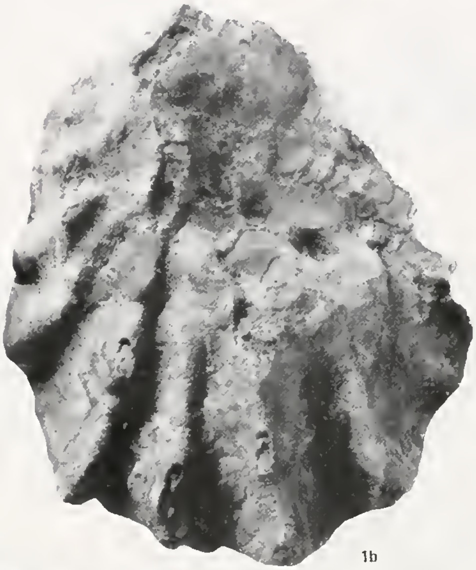
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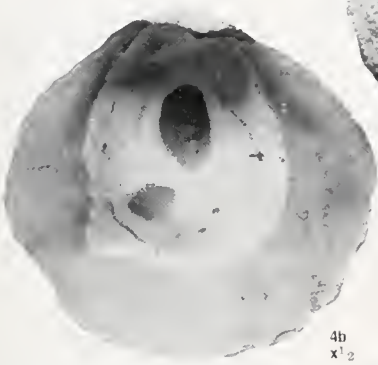
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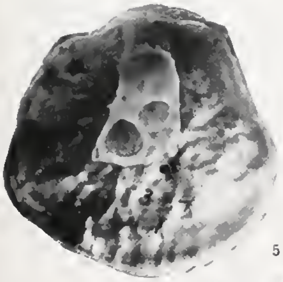
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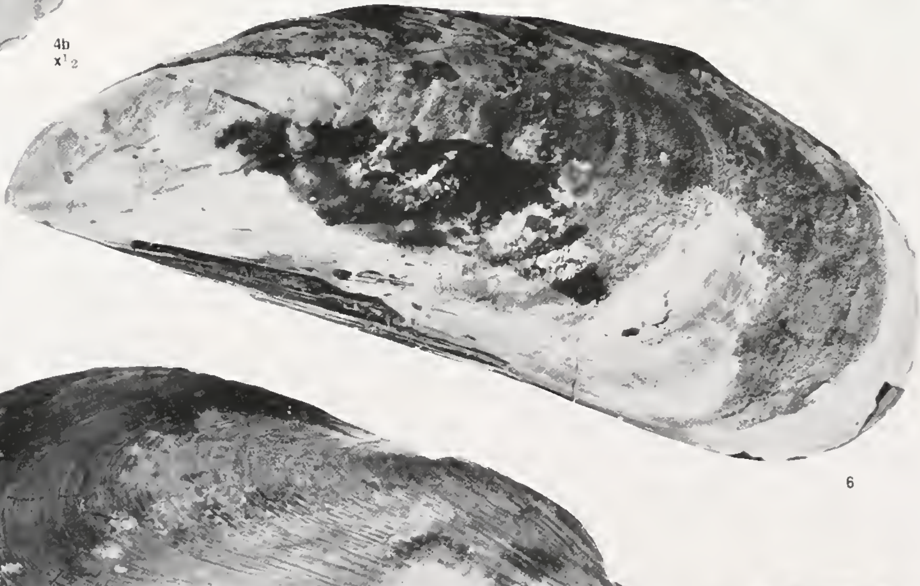
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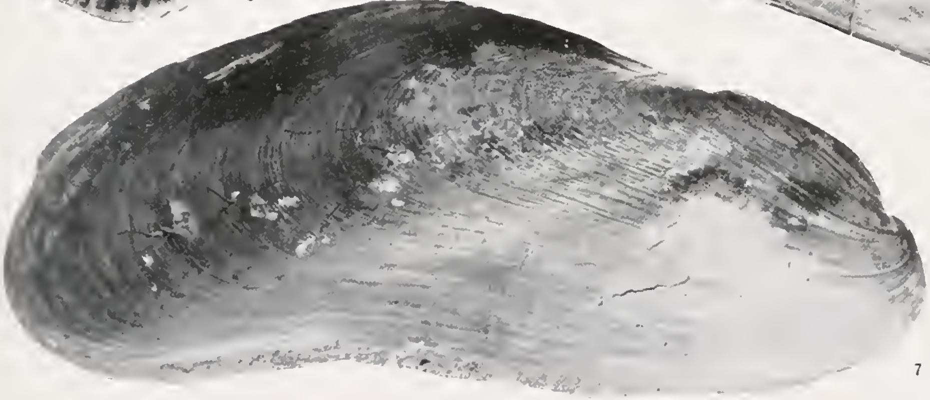
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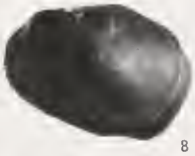
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EXPLANATION OF PLATE 13

Figs. 1. *Periploma planiuscula* Sowerby, Recent specimen from Pt. Conception, Calif., No. 130 S. D. S. N. H. Fig. 1*a*, exterior of right valve; fig. 1*b*, interior of the same valve showing the hinge apparatus and the pallial sinus; length 49 mm .... page 255

Figs. 2. *Pandora punctata* Conrad, specimen No. 121 S. D. S. N. H., donated from the collection at Stanford University where it was labeled 149, upper San Pedro (Palos Verdes), upper Pleistocene of San Pedro. Fig. 2*a*, exterior of the right valve; fig. 2*b*, interior of the same valve; length 31 mm.......... page 262

Figs. 3. *Astarte alaskensis* Dall, Recent specimen from Puget Sound, labeled A in the collection at Stanford University. Fig. 3*a*, interior of left valve; fig. 3*b*, exterior of the same valve; length 25 mm.......... page 268

Fig. 4. *Verticordia ornata* (d'Orbigny), Recent specimen labeled 40–1A in the collection at Stanford University, dredged at Santa Barbara. Exterior of left valve, × 5, length 5.5 mm. This little species is interesting because it is known also from China and the Antilles........ page 266

Figs. 5. *Pandora grandis* Dall, Recent specimen from Puget Sound, labeled 1631A in the collection at Stanford University. Fig. 5*a*, interior of right valve; fig. 5*b*, exterior of left valve; length 42 mm.......... page 261

Figs. 6. *Thracia* (*Cyathodonta*) *undulata* (Conrad), Recent specimen from San Diego, labeled 45–1A in the collection at Stanford University. Fig. 6*a*, exterior of right valve, natural size, length 32 mm.; fig. 6*b*, hinge of right valve, × 2.......... page 259

Figs. 7. *Crassitellites antillarum* (Reeve), specimen No. 122 S. D. S. N. H., from locality 32, near Santa Rosalia, Lower California, probably Pliocene. Fig. 7*a*, interior of right valve; fig. 7*b*, exterior of the same valve; length, 79 mm.......... page 271

Fig. 8. *Thracia* (*Thracia*) *trapezoides* Conrad, specimen No. 123 S. D. S. N. H., from locality 41, middle Miocene south of Mayfield, Santa Clara Co., middle California. Exterior of left valve, length 42 mm.......... page 257

Figs. 9. *Cardita ventricosa* Gould, specimen No. 125 S. D. S. N. H., from the lower Pleistocene of Stanford University locality 533, on old road (elevation about 1150′) about 1½ mi. S. 15° E. of Shephard's, on ridge between Casitas Creek and the Ocean, Ventura Quadrangle, Ventura Co. Fig. 9*a*, interior of right valve; fig. 9*b*, exterior of the same valve; both views × 2, length 17 mm.......... page 272

Figs. 10. *Glans minuscula*, new species, type, specimen No. 126 S. D. S. N. H., from locality 78, upper Pleistocene terrace near Seacliff, Ventura Co. Fig. 10*a*, exterior of right valve; fig. 10*b*, interior of same valve; both views × 3, length 11 mm. This species was formerly called *Cardita subquadrata*.......... page 277

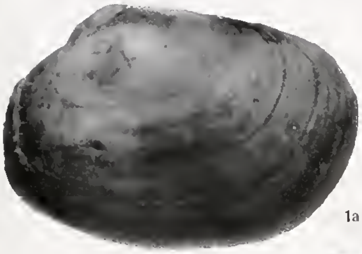
Fig. 11. *Cardita ventricosa* Gould, specimen No. 124 S. D. S. N. H., from locality 218, upper Pliocene of Sulphur Canyon east of South Mt., Ventura Co. Exterior of left valve, × 2, length 13 mm.......... page 272

Fig. 12. *Donax gouldii* Dall, specimen No. 127 S. D. S. N. H., from locality 99, upper Pleistocene terrace west of Newport, Los Angeles Co. Interior of the right valve, × 2, length 16.5 mm. The exterior of this specimen where the surface is intact is nearly smooth (hence its old name *lævigatus*, preoccupied); but where the surface has been weathered and removed there are pairs of fine radial knife-edges as in the *Glycymeris* shown on plate 1, fig. 21*b*... page 380

Figs. 13. *Calyptogena pacifica* Dall, Recent specimen from Alaska, labeled 110A in the collection at Stanford University. Fig. 13*a*, interior of the left valve; fig. 13*b*, exterior of the same valve; length 41 mm.......... page 278

Figs. 14. *Petricola carditoides* (Conrad), specimen No. 128 S. D. S. N. H., from locality 40, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Fig. 14*a*, interior of the right valve; fig. 14*b*, exterior of the same valve; length 38 mm. This species is very variable in outline, taking the shape of the hole or crevice in which it lives.......... page 355

Fig. 15. *Thyasira bisecta* (Conrad) variety *nipponica* Yabe and Nomura, specimen No. 129 S. D. S. N. H., from the Kawabata series, upper Pliocene or Pleistocene of Japan. Exterior of right valve, length 63 mm. This form is hardly to be distinguished from the North American form *bisecta* (Conrad) + *disjuncta* (Gabb).......... page 281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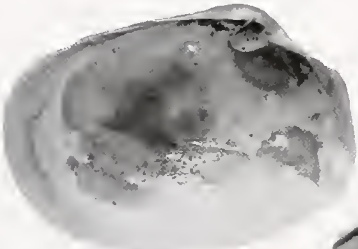
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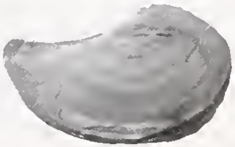
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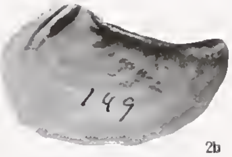
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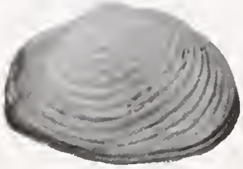
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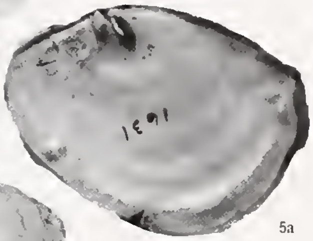
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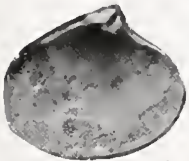
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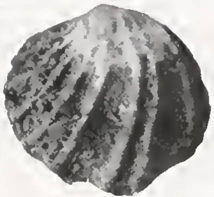
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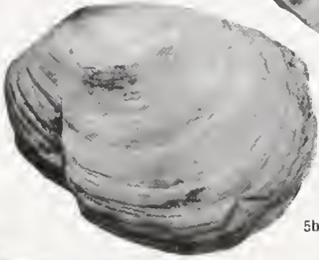
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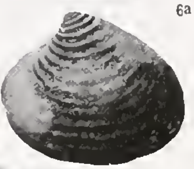
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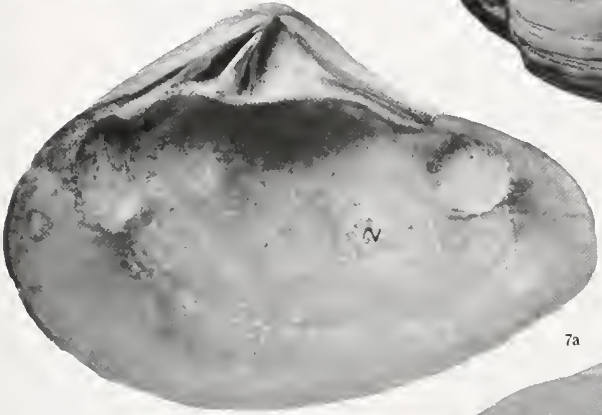
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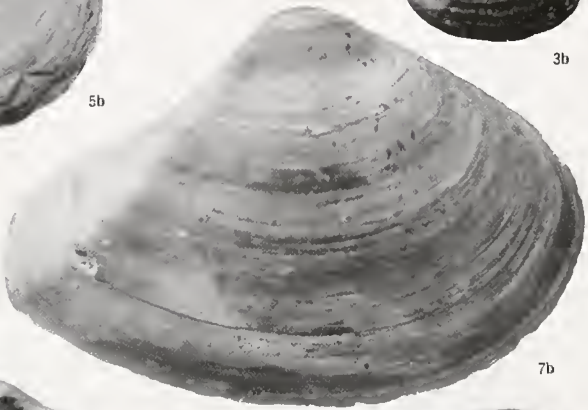
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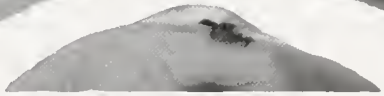
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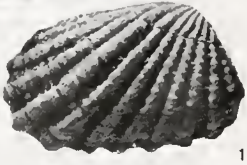
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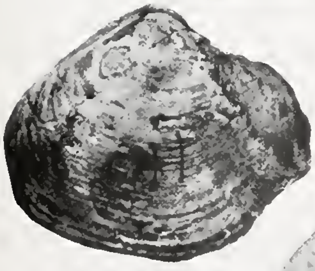
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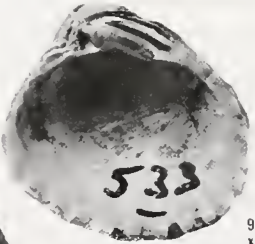
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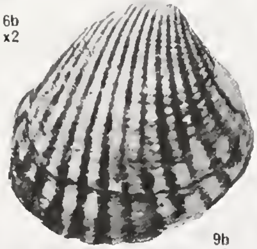
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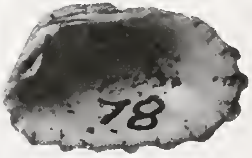
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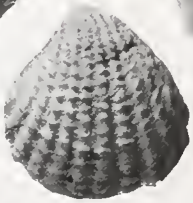
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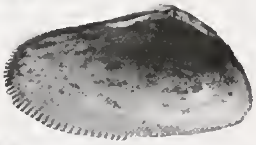
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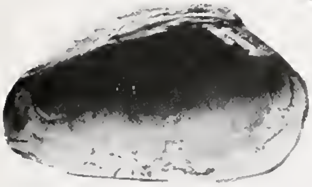
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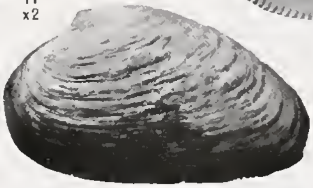
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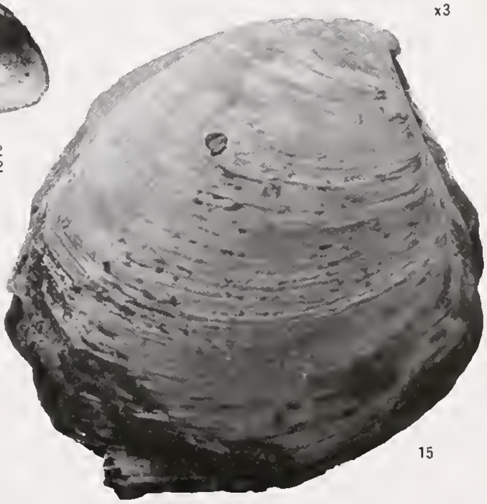
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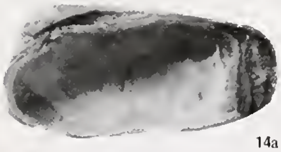
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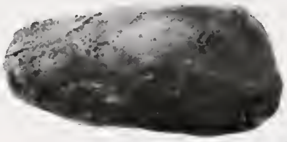
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EXPLANATION OF PLATE 14

FIGS. 1. *Divaricella dentata* (Wood), variety *eburnea* (Reeve), Recent specimen from Puerto Angeles, Oaxaca, Mexico, labeled A in the collection at Stanford University. Fig. 1*a*, exterior of the right valve; fig. 1*b*, interior of the same valve, length 24 mm. This species is closely related to *divaricata* (Linnæus). The writers do not consider the differences between the Atlantic and Pacific forms of *dentata* of more than varietal significance .... page 296

FIG. 2. *Lucina* (*Here*) *excavata* Carpenter, specimen No. 131 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, Los Angeles Co. Interior of left valve, length 12.5 mm. This species is better known as *richthofeni* Gabb.................................... page 290

FIG. 3. *Yoldia cooperi* Gabb, Recent specimen from Halfmoon Bay. View of the interior of the left valve. The exterior of this same specimen is shown on plate 1, fig. 13 .... page 128

FIGS. 4. *Lucina* (*Myrtea*) *nuttallii* Conrad, Recent specimen in the collection at Stanford University labeled 2270A, found on sandy mud flats between tides, San Diego. Fig. 4*a*, interior of the left valve; fig. 4*b*, interior of the right valve; length 26 mm........................ page 288

FIG. 5. *Lucina* (*Here*) *excavata* Carpenter, specimen No. 132 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, Los Angeles Co. Exterior of left valve, length 20 mm..... page 290

FIGS. 6. *Macoma balthica* (Linnæus), young specimen, No. 134 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Fig. 6*a*, interior of right valve; fig. 6*b*, interior of left valve; length 13.5 mm. The exteriors of this specimen are shown on plate 20, figs. 7*a*, 7*b*.. page 371

FIG. 7. *Macoma moesta* (Deshayes) variety *acolasta* Dall, specimen No. 135 S. D. S. N. H., from locality 74, upper Pleistocene terrace near Goleta, Santa Barbara Co. Interior of right valve, length 20 mm. The exterior of this specimen is shown on plate 20, fig. 10...... page 371

FIGS. 8. *Lucina* (*Myrtea*) *tenuisculpta* Carpenter form *approximata* (Dall), specimen No. 136 S. D. S. N. H., from the Nob Hill cut, lower San Pedro Pleistocene of San Pedro, Los Angeles Co. Fig. 8*a*, interior of right valve; fig. 8*b*, exterior of the same valve; length 8.6 mm. The living southern form *approximata* is distinguished only by the stronger radial striations, and it is probable that the typical form living near Vancouver Island differs only in the state of preservation.. page 289

FIGS. 9. *Tellina meropsis* Dall, Recent specimen from San Diego, labeled 277A in the collection at Stanford University. Fig. 9*a*, interior of right valve; fig. 9*b*, interior of left valve; length 15 mm. These interior views show faintly the lateral teeth distant from the beak that distinguish this form from a *Macoma*. The exterior views are given on plate 20, figs. 9*a*, 9*b*. *T. reclusa* Dall may be the same species, and *T. wilsoni* Anderson and Martin, from the middle Miocene, is closely related.. page 359

FIG. 10. *Lucina* (*Here*) *excavata* Carpenter, specimen No. 133 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, Los Angeles Co. Interior of right valve, length 18 mm.... page 290

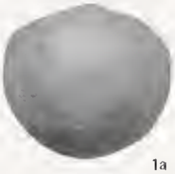
FIGS. 11. *Macoma planiuscula*, new species, type, Recent specimen from Nunivak Isl., Alaska, labeled 301-1A in the collection at Stanford University. Fig. 11*a*, interior of right valve; fig. 11*b*, interior of left valve, length 23.5 mm. The exteriors of this specimen are shown on plate 20, figs. 8*a*, 8*b*.. page 372

FIGS. 12. *Taras parilis* (Conrad), Recent specimen from San Ignacio Lagoon, Lower California, labeled 1657A in the collection at Stanford University. Fig. 12*a*, interior of right valve; fig. 12*b*, exterior of the same valve; length 18 mm. When living, this species is known as *sericatus* (Reeve).. page 295

FIGS. 13. *Semele decisa* (Conrad), specimen No. 137 S. D. S. N. H., from Los Cerritos, Signal Hill, San Pedro, upper Pleistocene. Fig. 13*a*, hinge of right valve; fig. 13*b*, exterior of the same valve; length 48 mm.. page 376

FIGS. 14. *Taras orbellus* (Gould), Recent specimen from San Diego, labeled 1658-3A in the collection at Stanford University. Fig. 14*a*, interior of right hinge, × 2; fig. 14*b*, exterior of the same valve, natural size; length 25.5 mm. This is an unusually plump form, like the form *aleuticus* (Dall), the opposite extreme from *subquadratus* (Carpenter)............ page 293

(*Continued on page 911*)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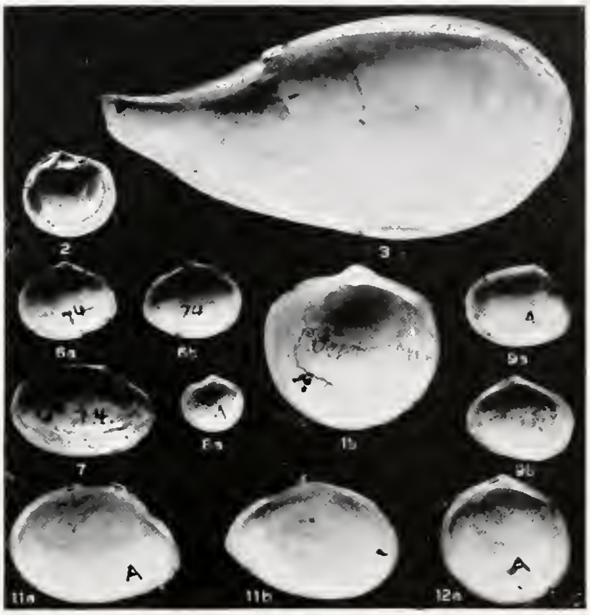
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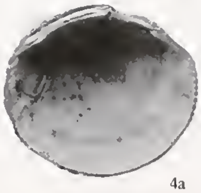
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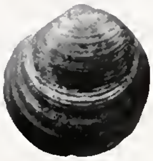
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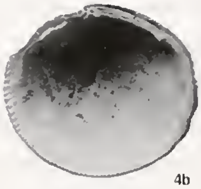
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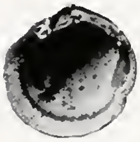
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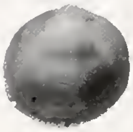
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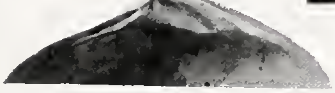
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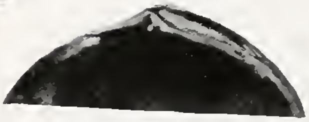
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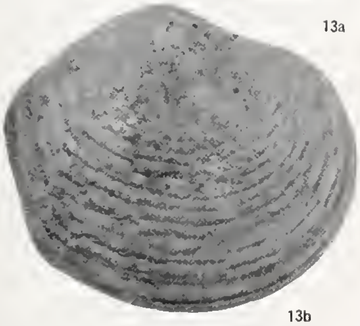
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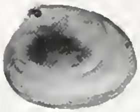
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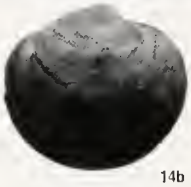
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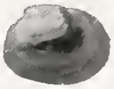
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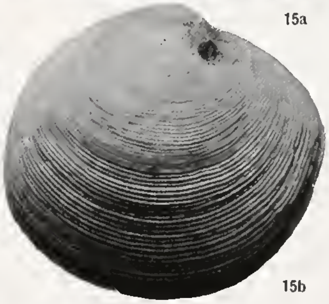
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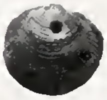
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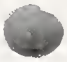
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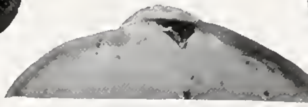
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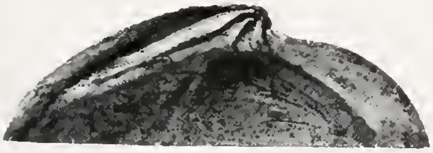
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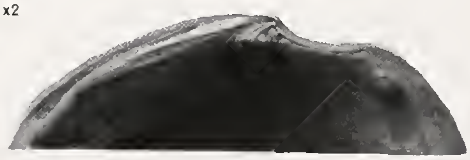
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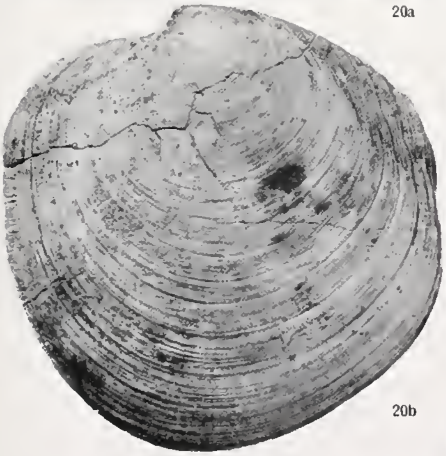
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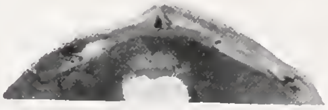
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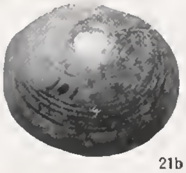
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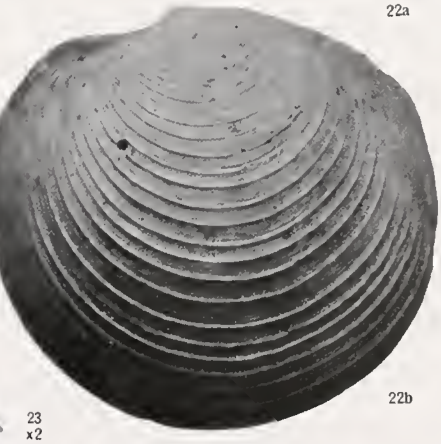
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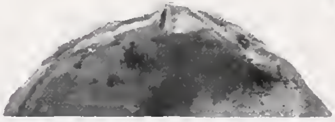
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EXPLANATION OF PLATE 14—(Continued)

FIGS. 15. *Lucina (Myrtea) californica* Conrad, specimen No. 138 S. D. S. N. H., from the San Pedro Pleistocene. Fig. 15*a*, interior of the right hinge; fig. 15*b*, exterior of the same valve; length 44 mm . . . . page 285

FIG. 16. *Rochefortia tumida* (Carpenter), Recent specimen labeled 68–4 in the collection at Stanford University, found in the gill cavity of the sand crab, *Blepharipoda occidentalis*, from Pismo, California. Interior of the left valve (note that the anterior extremity is the longer), × 3, length 6 mm . . . . page 301

FIG. 17. *Rochefortia tumida* (Carpenter), Recent specimen from the same lot as the last. Exterior of the right valve, × 3, length 5 mm. The dark material in the center of the hinge is ligament, not a tooth . . . . page 301

FIG. 18. *Lucina (Myrtea) nuttallii* Conrad, specimen No. 139 S. D. S. N. H., from locality 216, basal Pliocene east of Fernando Pass, Los Angeles Co. Exterior of right valve, length 14 mm. page 288

FIGS. 19. *Chironia suborbicularis* (Montagu) variety *laperousii* Deshayes, Recent specimen from Orcas Island, Puget Sound, labeled 65–2A in the collection at Stanford University. Fig. 19*a*, interior of the right hinge, × 2; fig. 19*b*, exterior of the right valve, natural size; length 25 mm. The dark colored material in the center of the hinge is entirely ligament. There is no tooth nor hinge plate below it . . . . page 300

FIGS. 20. *Lucina (Miltha) xantusi* (Dall), specimen No. 140 S. D. S. N. H., from locality 217*a*, middle Pliocene of Holser Canyon, Los Angeles Co. Fig. 20*a*, interior of left hinge; fig. 20*b*, exterior of left valve; length 59 mm . . . . page 291

FIGS. 21. *Lucina (Myrtea) californica* Conrad, specimen No. 142 S. D. S. N. H., from locality 101, upper Pliocene of Bath House Beach, Santa Barbara. Fig. 21*a*, hinge of left valve, × 2; fig. 21*b*, exterior of the same valve; length 24.5 mm . . . . page 285

FIGS. 22. *Lucina (Myrtea) acutilineata* Conrad, specimen No. 141 S. D. S. N. H., from the Pleistocene of San Pedro, Los Angeles Co. Fig. 22*a*, interior of left hinge; fig. 22*b*, exterior of the same valve . . . . page 286

FIG. 23. *Cumingia lamellosa* Sowerby, specimen No. 143 S. D. S. N. H., from the upper Pliocene of locality 151, on Maria Ygnacia Creek about 1½ mi. northeast of Goleta, Santa Barbara Co. Interior of right hinge, × 2, length 23 mm. This specimen is also shown on plate 19, fig. 1 . . . . page 378

EXPLANATION OF PLATE 15

FIGS. 1. *Dosinia ponderosa* (Gray), Recent specimen from San Ignacio Lagoon, Lower California, labeled 1893A in the collection at Stanford University. Fig. 1*a*, exterior of right valve; fig. 1*b*, interior of right valve; fig. 1*c*, hinge of left valve; length 75 mm. This is a medium sized or small specimen. The species sometimes has more protruding umbones........ page 351

FIGS. 2. *Dosinia ponderosa* (Gray) variety *jacalitosana* Arnold, specimen No. 144 S. D. S. N. H., from locality 29, middle Pliocene of Balboa Park, San Diego. Fig. 2*a*, hinge of right valve; fig. 2*b*, exterior of the same valve; both views × $\frac{2}{3}$, length 122 mm.................. page 352

FIG. 3. *Dosinia ponderosa* (Gray) variety *jacalitosana* Arnold, specimen No. 145 S. D. S. N. H., from locality 29, middle Pliocene of Balboa Park, San Diego. Hinge of left valve, × $\frac{2}{3}$, length of specimen 102 mm. The dorsal margin is somewhat eroded........................ page 352

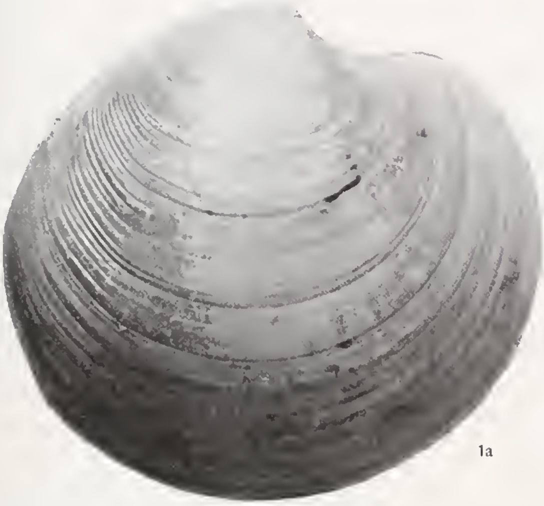
FIG. 4. *Dosinia ponderosa* (Gray) variety *longidens*, new variety, type specimen, No. 146 S. D. S. N. H., from well core taken near Bakersfield, upper Miocene (possibly middle Miocene). Hinge of left valve showing elongate anterior tooth, length of specimen 72 mm. The drill has distorted this specimen, crushing somewhat the posterior dorsal margin and elongating the anterior; but the hinge plate is intact.. page 353

FIG. 5. *Psephidia lordi* (Baird), Recent specimen from Friday Harbor, Puget Sound, labeled 232A in the collection at Stanford University. Exterior of left valve, × 3, length 6 mm. This species is sometimes relatively less elongate.. page 336

FIG. 6. *Psephidia lordi* (Baird), specimen from the same lot as the specimen shown in fig. 5. Exterior of right valve, × 3, length 6.2 mm.. page 336

FIGS. 7. *Psephidia lordi* (Baird), specimen from the same lot as the specimens shown in figs. 5 and 6. Fig. 7*a*, interior of right valve; fig. 7*b*, interior of left valve; both views × 3, length 6.5 mm.. page 336

FIGS. 8. *Transennella tantilla* (Gould), Recent specimen from Monterey, California, labeled 235A in the collection at Stanford University. Fig. 8*a*, interior of right valve; fig. 8*b*, interior of left valve; both views × 3, length 6 mm.. page 338



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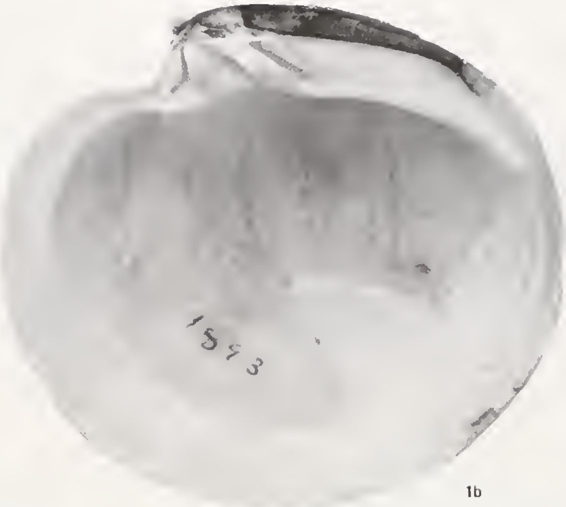

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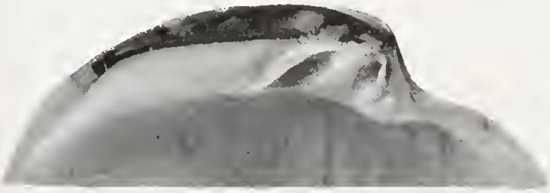

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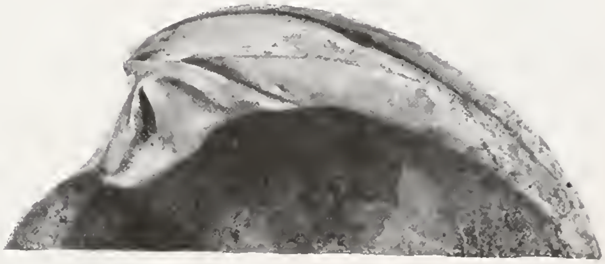

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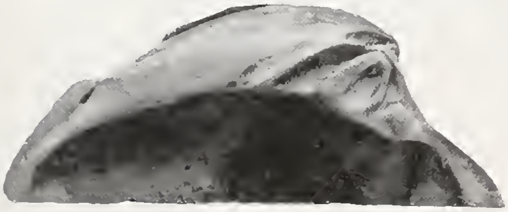

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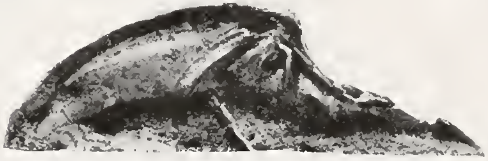

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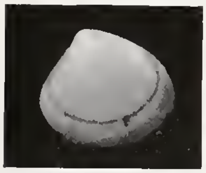

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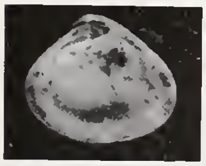

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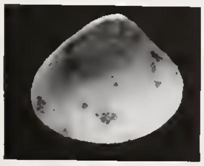

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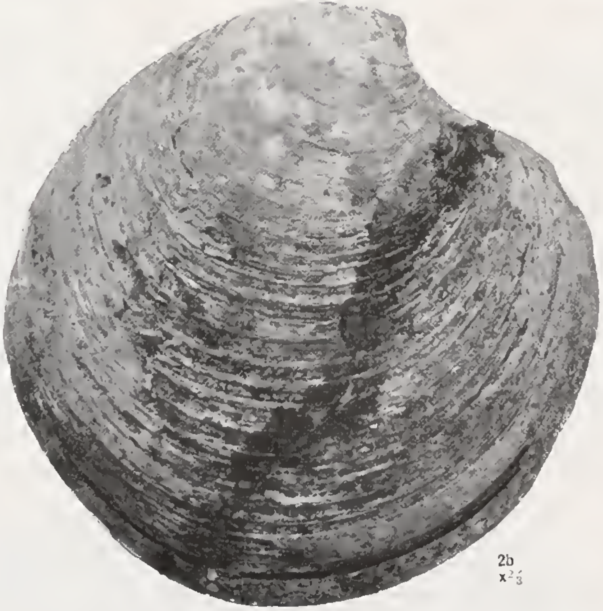

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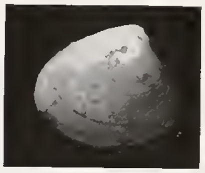

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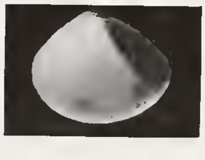

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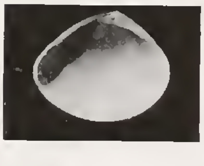

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EXPLANATION OF PLATE 16

FIGS. 1. *Venus* (*Chione*) *succincta* Valenciennes, specimen No. 147 S. D. S. N. H., from locality 97, upper Pleistocene (Palos Verdes) terrace about 5 mi. E. N. E. of the town of Newport Beach, Orange Co. Fig. 1*a*, interior of left valve; fig. 1*b*, exterior of the left valve; length 48 mm. Four specimens of the left valve of this species, all from the same locality, are illustrated here to show the variation in form. The hinges vary as well as the shape and sculpture.......... page 321

FIGS. 2. *Venus* (*Chione*) *succincta* Valenciennes, specimen No. 148 S. D. S. N. H., from the same lot as the specimen shown in figs. 1. Fig. 2*a*, interior of left valve; fig. 2*b*, exterior of left valve; length 50 mm.......... page 321

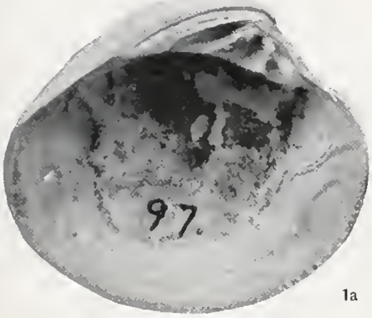
FIG. 3. *Venus* (*Chione*) *succincta* Valenciennes, specimen No. 149 S. D. S. N. H., from the same lot as the specimens shown in figs. 1 and 2. Exterior of left valve, length 50 mm. This specimen is intermediate in shape between the specimens shown in figs. 1 and 2........ page 321

FIG. 4. *Venus* (*Chione*) *succincta* Valenciennes, specimen No. 150 S. D. S. N. H., from the same lot as the specimens shown in figs. 1, 2, and 3. Exterior of left valve, length 42 mm. This is the variation commonly known as *undatella;* but it is not of significance............ page 321

FIGS. 5. *Venus* (*Chione*) *gnidia* Broderip and Sowerby, specimen No. 611 in the collection at Stanford University, from the Palos Verdes terrace, upper Pleistocene of San Diego. Fig. 5*a*, exterior of left valve; fig. 5*b*, hinge of left valve; both views × ⅔, length 98 mm........ page 318

FIGS. 6. *Venus* (*Chione*) *elsmerensis* (English), specimen No. 151 S. D. S. N. H., from locality 202, lower Pliocene of Elsmere Canyon, Los Angeles Co. Fig. 6*a*, exterior of left valve; fig. 6*b*, hinge view of left valve; length 75 mm. This specimen from the type locality of the species shows its close relationship with *V. gnidia*.......... page 319

FIG. 7. *Venus* (*Chione*) *elsmerensis* (English), specimen No. 152 S. D. S. N. H., from the same locality as the specimen shown in figs. 6. Hinge of right valve, length 83 mm. +.............. page 319



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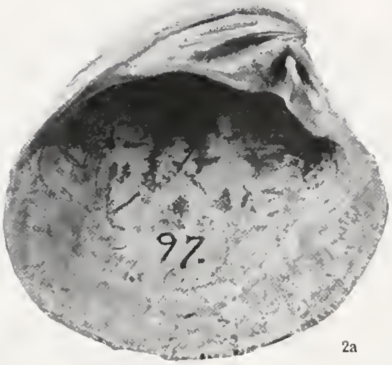

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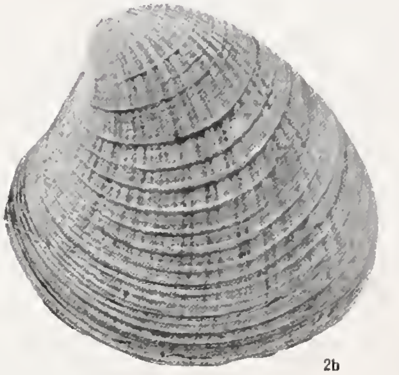

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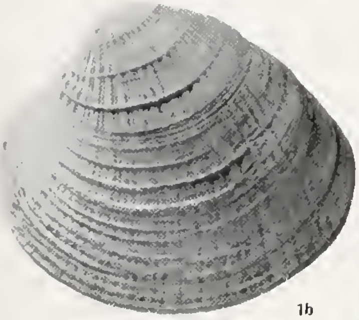

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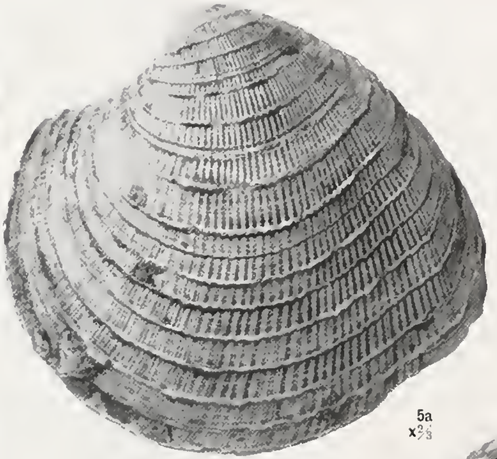

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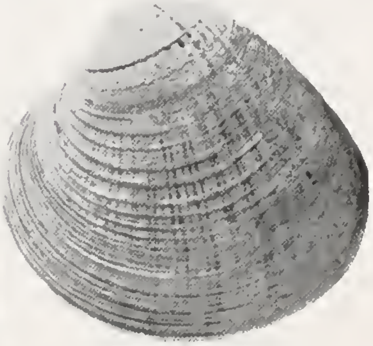

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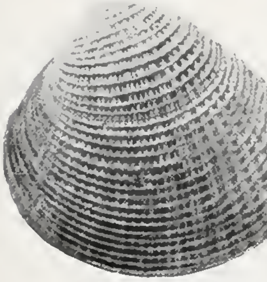

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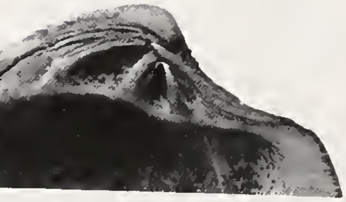

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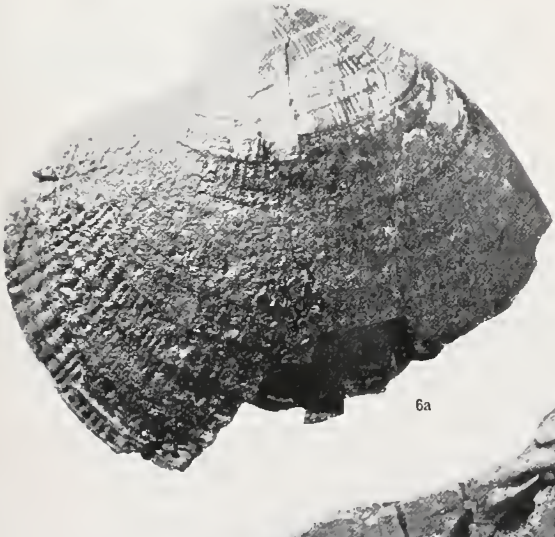

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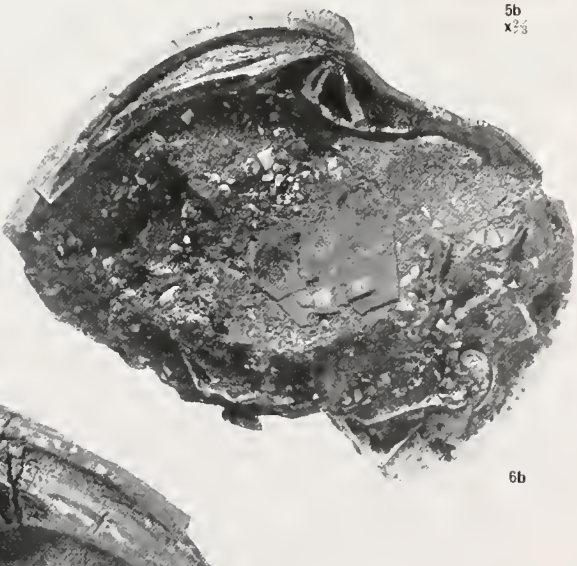

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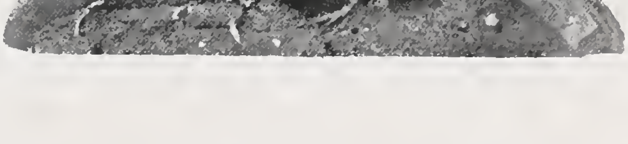

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EXPLANATION OF PLATE 17

FIG. 1. *Venus* (*Chione*) *securis* Shumard, typical variety, specimen No. 622 in the collection at Stanford University, from the lower Wildcat formation, probably lower Pliocene, but possibly upper Miocene, Scotia Bluffs, Humboldt Co., northern California. Exterior of left valve, length 88 mm. . . . . page 320

FIGS. 2. *Venus* (*Chione*) *securis* Shumard variety *ensifera* Dall, specimen No. 623 in the collection at Stanford University, from the Miocene 2 mi. south of Yaquina Bay, Oregon. Fig. 2*a*, exterior of left valve; fig. 2*b*, dorsal view showing lunule and escutcheon; length 50 mm. . . . page 320

FIG. 3. *Venus* (*Chione*) *securis* Shumard variety *ensifera* Dall, specimen No. 624 in the collection at Stanford University, from the same locality as the specimen shown in figs. 2. Exterior of left valve, length 45 mm. . . . . page 320

FIGS. 4. *Venus* (*Chione*) *securis* Shumard variety *fernandoensis* (English), specimen No. 159 S. D. S. N. H., from locality 209, lower Pliocene of Elsmere Canyon. Fig. 4*a*, exterior of left valve; fig. 4*b*, dorsal view showing lunule and escutcheon; length 42 mm. The series of specimens shown in figs. 1 to 4 illustrates well the effects of weathering. The hard calcareous matrix was knocked from this one with a hammer, and the concentric lines as well as the boundary of the escutcheon are sharp. The lamellæ, of course, remained in the matrix. . . . . page 321

FIG. 5. *Venus* (*Chione*) *securis* Shumard variety *fernandoensis* (English), specimen No. 160 S. D. S. N. H., from locality 206, lower Pliocene of Elsmere Canyon. Exterior of left valve, length 23 mm. . . . . page 321

FIG. 6. *Venus* (*Chione*) *securis* Shumard variety *fernandoensis* (English), young or stunted form, specimen No. 161 S. D. S. N. H., from locality 209, lower Pliocene of Elsmere Canyon. Exterior of left valve, length 13 mm. . . . . page 321

FIG. 7. *Amiantis callosa* (Conrad), specimen No. 162 S. D. S. N. H., from the middle Pliocene (San Diego zone) of locality 217*b*, Holser Canyon, Los Angeles Co. Exterior of left valve, length 41 mm. . . . . page 348

FIGS. 8. *Amiantis callosa* (Conrad) variety *stalderi* (Clark), specimen No. 164 S. D. S. N. H., from well core taken near Bakersfield, upper or possibly middle Miocene. Fig. 8*a*, hinge of right valve, showing faintly the two close cardinal teeth; fig. 8*b*, exterior of right valve showing sculpture and general shape; length 28 mm. . . . . page 319

FIG. 9. *Amiantis callosa* (Conrad), specimen No. 163 S. D. S. N. H., from the middle Pliocene of locality 214, west of Fernando Pass, Los Angeles Co. Exterior of right valve, length about 50 mm. . . . . page 348

FIGS. 10. *Clementia* (*Compsomyax*) *subdiaphana* Carpenter, specimen No. 167 S. D. S. N. H., from the lower San Pedro, lower Pleistocene of Deadman Island, San Pedro Harbor. Fig. 10*a*, interior of right valve; fig. 10*b*, exterior of right valve; length 40 mm. . . . . page 334

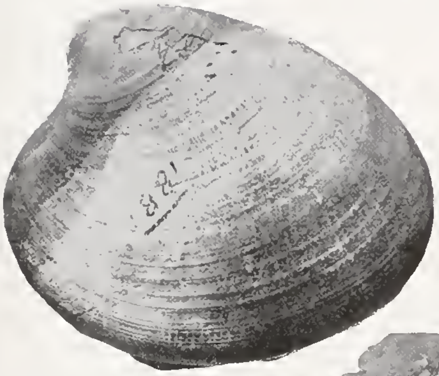
FIG. 11. *Amiantis callosa* (Conrad), specimen No. 625 in the collection at Stanford University, from the Pleistocene of San Pedro. Hinge of left valve, length of specimen 77 mm. . . . . page 348

FIG. 12. *Amiantis callosa* (Conrad), specimen No. 165 S. D. S. N. H., from locality 207, lower Pliocene of Elsmere Canyon, Los Angeles Co. Exterior of right valve, length of fragment 38 mm. It might be questioned that this identification is correct, as the specimen lacks the characteristic concentric ridges of *callosa;* but figs. 7 and 9 show what has happened. . . . . page 348

FIG. 13. *Amiantis callosa* (Conrad), specimen No. 166 S. D. S. N. H., from the same locality as the specimen shown in fig. 12. Hinge of right valve, fragment natural size. This specimen, though partly smooth like the last, has part of the sculpture remaining. Back of the umbo the shell is 5 mm. thick. . . . . page 348

FIG. 14. *Amiantis callosa* (Conrad), Recent specimen from San Diego, labeled 1894–2A in the collection at Stanford University. Interior of right valve, length 82 mm. . . . . page 348

FIG. 15. ? *Clementia* (*Compsomyax*) *subdiaphana* Carpenter, specimen No. 626 in the collection at Stanford University, from the upper Pliocene (?) of Cape Blanco, Oregon. Exterior of right valve, length 63 mm. This form does not have the typical shape of *C. subdiaphana* and may even be a *Pitar*, perhaps Conrad's *Dione brevilineata*. However, there is a similar Recent specimen in the collection at Stanford University that is surely no more than a variant of *C. subdiaphana*. The hinge is not exposed. . . . . page 334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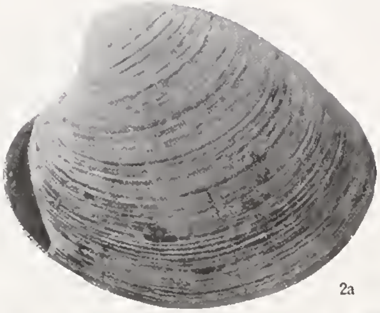
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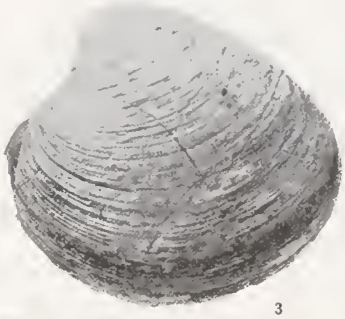
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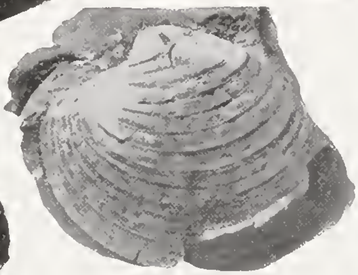
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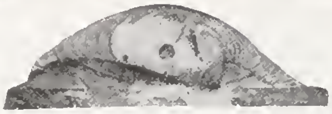
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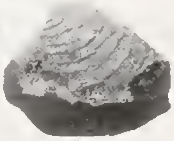
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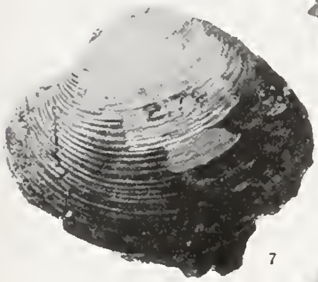
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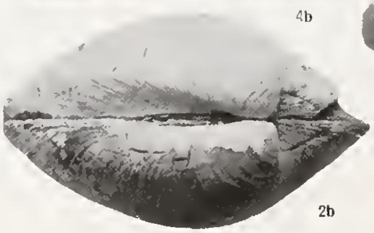
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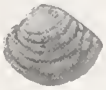
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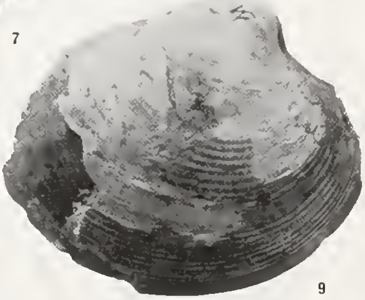
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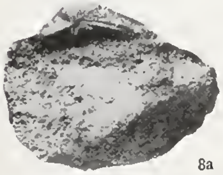
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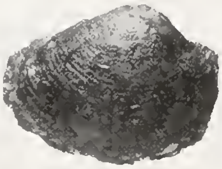
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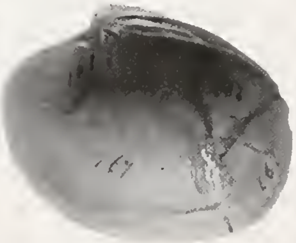
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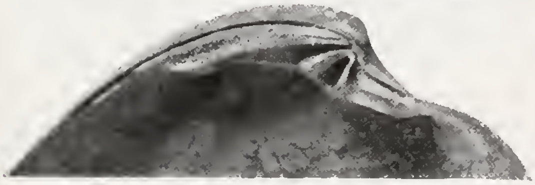
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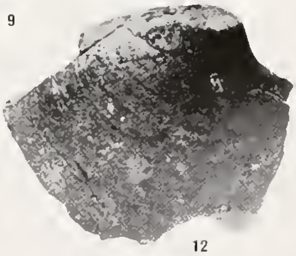
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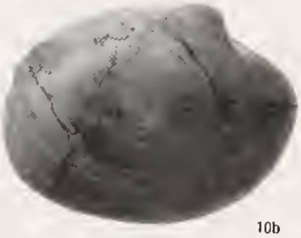
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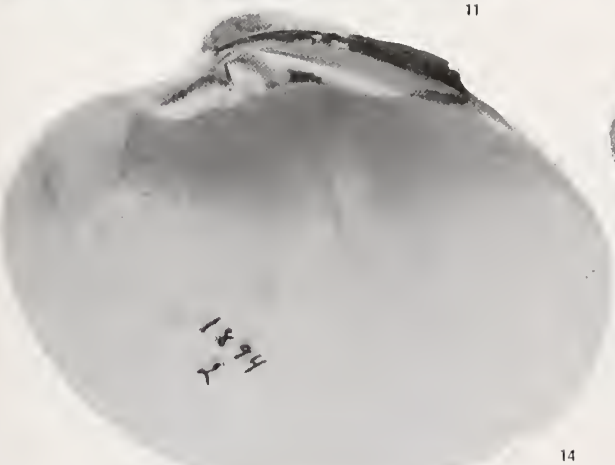

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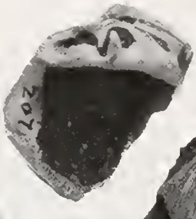

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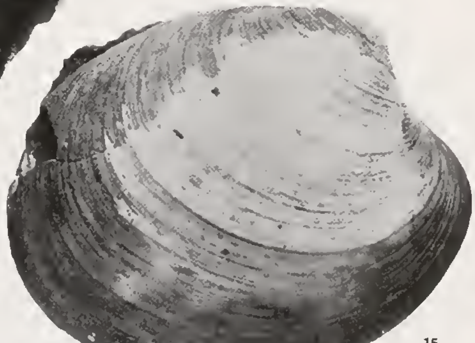
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EXPLANATION OF PLATE 18

FIGS. 1. *Venerupis* (*Protothaca*) *staminea* (Conrad), specimen No. 153 S. D. S. N. H., from locality 40, upper Pleistocene terrace along beach southwest of Goleta. Fig. 1*a*, interior of right valve; fig. 1*b*, exterior of right valve; length 50 mm. . . . . page 329

FIGS. 2. *Venerupis* (*Protothaca*) *staminea* (Conrad), specimen No. 154 S. D. S. N. H., from the same locality as the specimen shown in figs 1. Fig. 2*a*, interior of left valve; fig. 2*b*, exterior of left valve; length 44 mm. This specimen is relatively shorter than the last, but like most of the variations of this species it is without significance. . . . . page 329

FIGS. 3. *Venerupis* (*Protothaca*) *staminea* (Conrad) variety *ruderata* (Deshayes), specimen No. 155 S. D. S. N. H., from locality 74 near locality 40 where the specimens shown in figs. 1 and 2 came from. Fig. 3*a*, interior of right valve; fig. 3*b*, exterior of right valve; length 51 mm. This specimen illustrates the effect of the burrowing habit on both hinge and sculpture and shows how close the transition is to *Irus*. . . . . page 331

FIG. 4. *Saxidomus nuttalli* Conrad variety *giganteus* (Deshayes), young, figured specimen No. 156 S. D. S. N. H., from locality 74, found with the specimen shown in figs. 3. Interior view of right valve, length 47 mm. This cold-water variety is distinguished principally by its finer concentric sculpture . . . . page 342

FIGS. 5. *Irus lamellifer* (Conrad), Recent specimen from Monterey, labeled 1806A in the collection at Stanford University. Fig. 5*a*, interior of right valve; fig. 5*b*, exterior of the same valve; length (including protruding lamella) 27.5 mm . . . . page 332

FIGS. 6. *Irus lamellifer* (Conrad), Recent specimen from Monterey, from the same lot as the specimen shown in figs. 5. Fig. 6*a*, interior of left valve; fig. 6*b*, exterior of the same valve; length 27 mm. This elongate specimen partially illustrates the variability of this burrowing species . . . . page 332

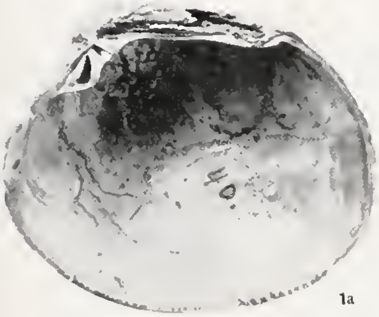
FIG. 7. *Irus lamellifer* (Conrad) variety *prelamellifer*, new variety, type, No. 157 S. D. S. N. H., from well core taken near Bakersfield, upper (possibly middle) Miocene. Exterior of right valve, length 21 mm. This specimen illustrates the high, thin, widely spaced lamellæ characteristic of this variety. The lamellæ are thinner and more delicate than the figure shows. . . . . page 332

FIG. 8. *Irus lamellifer* (Conrad), Recent specimen from the same lot as the specimens shown in figs. 5 and 6. Exterior of right valve, length 23 mm. This variation has a circular shape comparable to that of the variety *prelamellifer* . . . . page 332

FIGS. 9. *Venerupis* (*Callithaca*) *tenerrimo* (Carpenter), specimen No. 620 in the collection at Stanford University from the Palos Verdes of San Pedro, upper Pleistocene. Fig. 9*a*, hinge of left valve; fig. 9*b*, exterior of left valve; both views × ⅔, length 107 mm. . . . . page 327

FIG. 10. *Saxidomus nuttalli* Conrad, specimen No. 158 S. D. S. N. H., from locality 101, upper Pliocene of Santa Barbara. Hinge of left valve, length of specimen 75 mm. The sculpture on the early part of this shell suggests that it might belong to the variety *giganteus*. . . . . page 342

FIG. 11. *Saxidomus nuttalli* Conrad, specimen No. 621 in the collection at Stanford University, from Stanford University locality 206, Las Posas zone, lower Pleistocene, outcropping on the east bank of Barlow Canyon, Santa Paula Quadrangle, Ventura Co. Exterior of left valve, length 89 mm . . . . page 341



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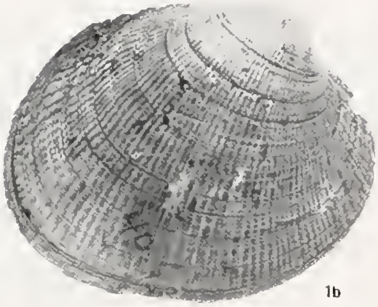

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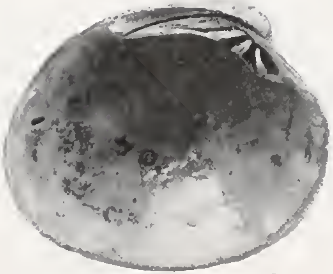
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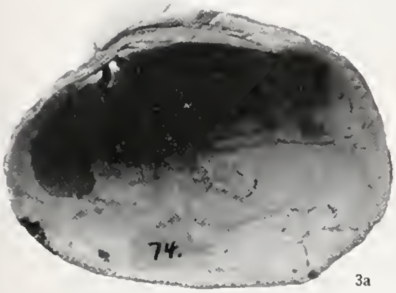

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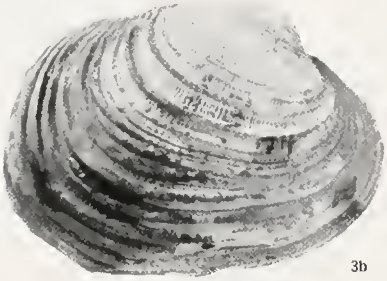

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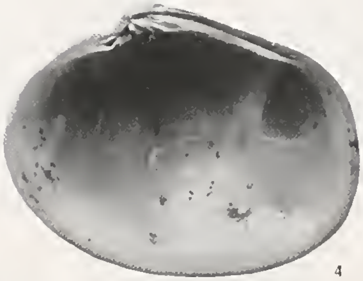
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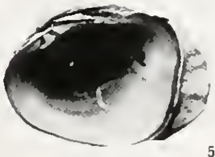
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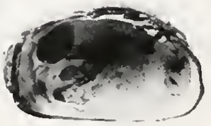
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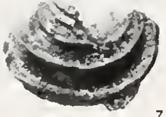
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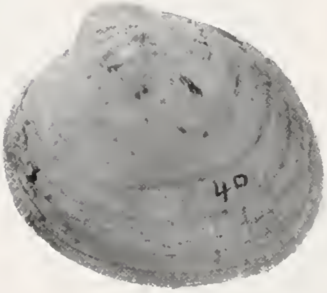

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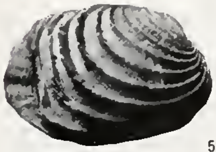
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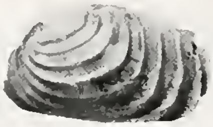
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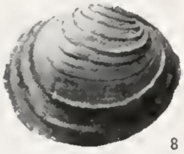
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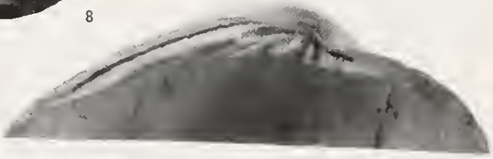
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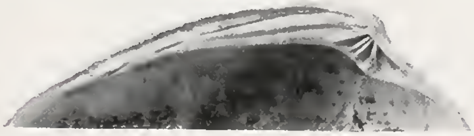
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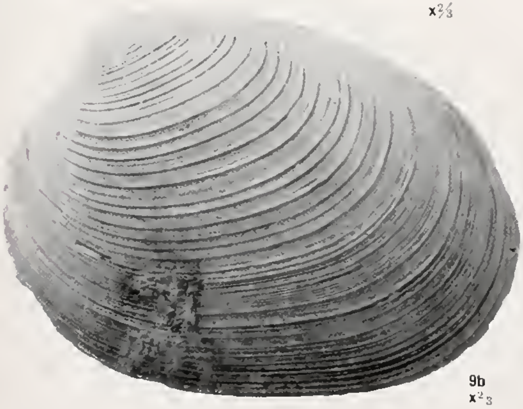
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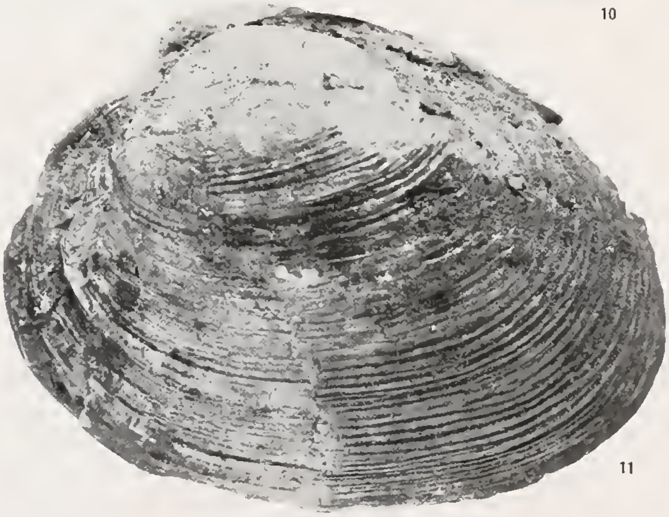
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EXPLANATION OF PLATE 19

FIG. 1. *Cumingia lamellosa* Sowerby, specimen No. 143 S. D. S. N. H., from the upper Pliocene of locality 151. Exterior of right valve, length 23 mm. The hinge of this specimen is shown on plate 14, fig. 23 .... page 378

FIG. 2. *Corbula (Lentidium) luteola* Carpenter, specimen No. 168 S. D. S. N. H., from locality 78, a low, upper Pleistocene terrace south of Seacliff Station, Ventura Co. Exterior of left valve, × 3, length 9.5 mm. When magnified this species is practically indistinguishable from *C. fragilis*. See also fig. 7 .... page 421

FIGS. 3. *Tivela stultorum* (Mawe), young, specimen No. 170 S. D. S. N. H., from locality 99, upper Pleistocene terrace west of Newport, Los Angeles Co. Fig. *3a*, exterior of right valve, natural size; fig. *3b*, interior of the same valve × 2; length 30 mm. Adults of this species often get very large and heavy. The species sometimes has a much smaller apical angle. See also fig. 8 .... page 340

FIG. 4. *Corbula (Corbula) gibbiformis*, new species, paratype, specimen No. 171 S. D. S. N. H., from a well core taken in the southwestern part of the San Joaquin basin, upper Etchegoin formation. Hinge of right valve, × 2, length 12 mm .... page 420

FIG. 5. *Corbula (Corbula) gibbiformis*, new species, type, specimen No. 172 S. D. S. N. H., found with the specimen shown in fig. 4. Exterior of right valve, × 2, length 13 mm .... page 420

FIG. 6. *Corbula (Corbula) gibbiformis*, new species, paratype, specimen No. 173 S. D. S. N. H., found with the other specimens of this species. Exterior of the left valve with part of a right valve showing behind, × 2, length 12 mm. The sculpture of this valve contrasts strikingly with that of the other .... page 420

FIG. 7. *Corbula (Lentidium) luteola* Carpenter, specimen No. 169 S. D. S. N. H., from the same locality as the specimen shown in fig. 2. Interior of the left valve, × 3, length 8.5 mm .... page 421

FIG. 8. *Tivela stultorum* (Mawe), reproduction of Mawe's original figure. The reproduction is the same size as the original, but the writers do not know whether Mawe's original was natural size or not .... page 340

FIG. 9. *Lævicardium (Nemocardium) centifilosum* (Carpenter), specimen No. 174 S. D. S. N. H., found with *Corbula gibbiformis*, upper Etchegoin. Exterior of right valve, length 18 mm. This species is more circular in outline and has stronger radials than the young of *Lævicardium elatum* .... page 311

FIG. 10. *Lævicardium (Nemocardium) centifilosum* (Carpenter), specimen No. 175 S. D. S. N. H., found with the specimen shown in fig. 9. Exterior of right valve, length 18 mm .... page 311

FIG. 11. *Lævicardium (Cerastoderma) ciliatum* (Fabricius), Recent specimen from Bering Sea, labeled 428A in the collection at Stanford University. Exterior of left valve, length 50 mm .... page 310

FIG. 12. *Lævicardium (Cerastoderma) decoratum* (Grewingk), specimen No. 627 in the collection at Stanford University, from the upper Pliocene or Pleistocene of Elk River, Oregon. Exterior of left valve, length 23 mm .... page 308

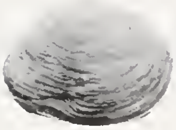
FIG. 13. *Lævicardium (Cerastoderma) californiense* (Deshayes), Recent specimen from Griffin Bay, San Juan Island, Puget Sound, labeled 250-1A in the collection at Stanford University. Exterior of left valve, length 44 mm .... page 309

FIG. 14. *Lævicardium (Cerastoderma) corbis* (Martyn), reproduction of Martyn's original figure, reduced to half the size of Martyn's excellent drawing .... page 307

FIG. 15. *Lævicardium (Trachycardium) quadragenarium* (Conrad), young Recent specimen from San Diego, labeled 1614A in the collection at Stanford University. Exterior of left valve, length 44 mm .... page 306

FIG. 16. *Lævicardium (Cerastoderma) californiense* Deshayes, Recent specimen from Amaknak Island, Unalaska Group, Alaska, labeled A in the collection at Stanford University. Exterior of left valve, length 68 mm. This coarse, northern form contrasts strikingly with the Puget Sound form shown in fig. 13, but the differences are due entirely to the environment .... page 309

FIG. 17. *Lævicardium (Cerastoderma) corbis* (Martyn), Recent specimen from Seven Mile Beach, middle California, No. 176 S. D. S. N. H. Exterior of right valve, length 69 mm .... page 307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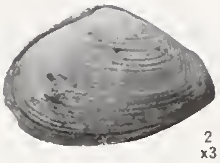
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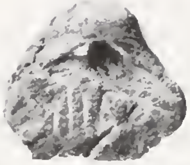
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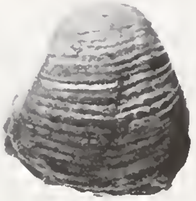
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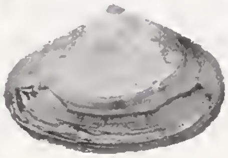
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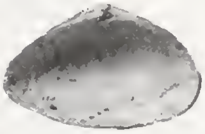
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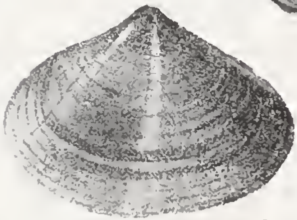
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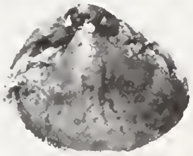
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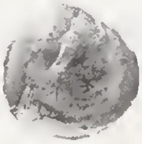
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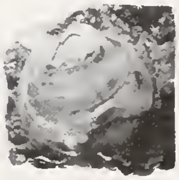
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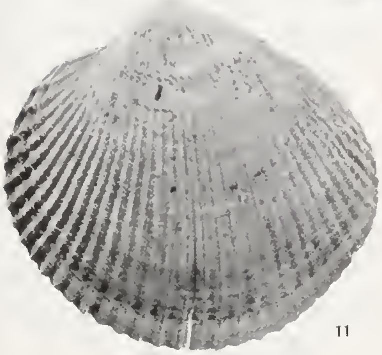
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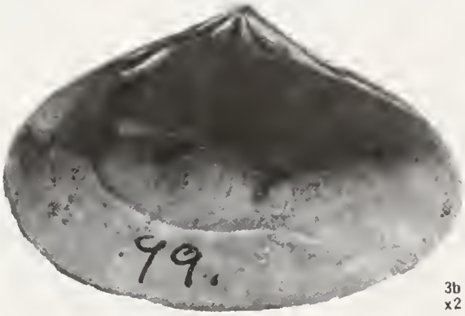

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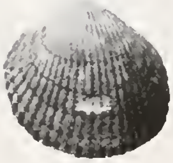
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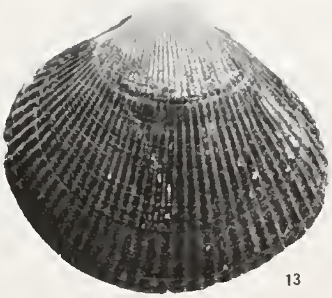
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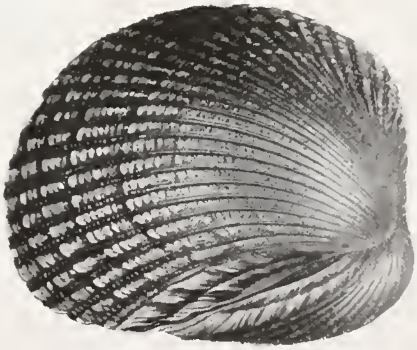
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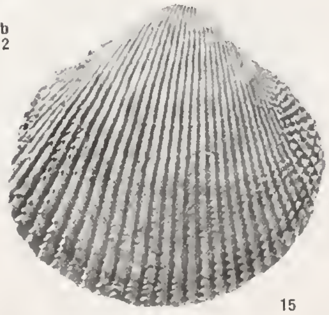
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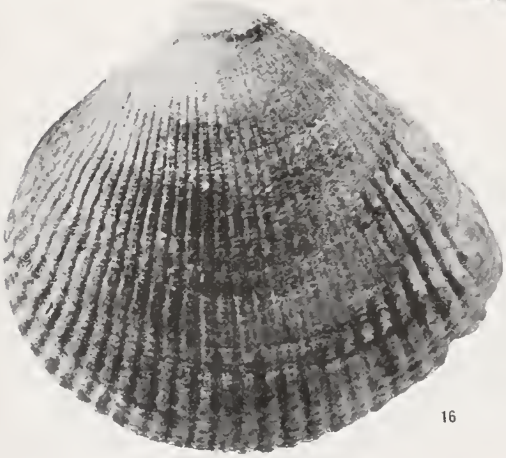
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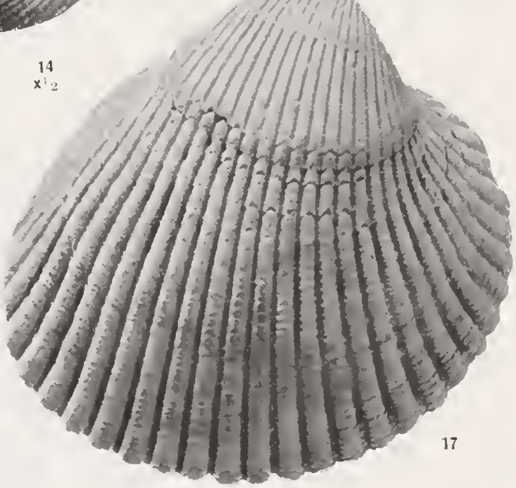
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EXPLANATION OF PLATE 20

FIGS. 1. *Macoma carlottensis* Whiteaves, Recent specimen from the type locality, loaned by the Museum of the Canadian Geological Survey at Ottawa. Fig. 1*a*, exterior of right valve; fig. 1*b*, exterior of left valve, natural size. This species has usually been known under its synonym *inflatula* Dall . . . . page 372

FIGS. 2. *Macoma carlottensis* Whiteaves, Recent specimen from British Columbia, loaned by the Museum of the Canadian Geological Survey at Ottawa. Fig. 2*a*, exterior of right valve; fig. 2*b*, exterior of left valve, natural size. The forms shown in figs. 1 and 2 occur together and grade into each other completely . . . . page 372

FIG. 3. *Macoma moesta* (Deshayes), reproduction of Dall's original figure of *M. krausei* Dall, from Icy Cape, Arctic Ocean. Exterior of right valve, length 23 mm. *M. krausei* was later admitted by Dall to be a synonym of *moesta*. . . . . page 370

FIGS. 4. *Macoma moesta* (Deshayes) variety *acolasta* Dall, reproduction of Dall's original figures. Fig. 4*a*, exterior of right valve; fig. 4*b*, interior of left valve; natural size. These illustrations show how close this variety is to the typical form . . . . page 371

FIG. 5. *Macoma inquinata* (Deshayes), reproduction of Reeve's figure of this species, Conch. Icon., Vol. 17, *Tellina*, pl. 30, species 164, 1867, Recent, Vancouver Island. Exterior of left valve, natural size. This species is very variable in shape . . . . page 367

FIGS. 6. *Macoma secta* (Conrad), specimen No. 177 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, north of the Santa Clara Valley, Los Angeles Co. Fig. 6*a*, exterior of left valve; fig. 6*b*, exterior of right valve; length 53 mm. This common species is probably reported sometimes as *nasuta* or other species, for as a fossil it loses some of its characteristic appearance . . . . page 374

FIGS. 7. *Macoma balthica* (Linnæus), young, specimen No. 134 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Fig. 7*a*, exterior of right valve; fig. 7*b*, exterior of left valve; length 13.5 mm. The interiors of this specimen are shown on plate 14, figs. 6*a*, 6*b* . . . . page 371

FIGS. 8. *Macoma planiuscula*, new species, type, Recent specimen from Nunivak Island, Alaska, labeled 301–1A in the collection at Stanford University. Fig. 8*a*, exterior of right valve; fig. 8*b*, exterior of left valve, length 23.5 mm. The interiors of this specimen are shown on plate 14, figs. 11*a*, 11*b*. The species is rather variable in shape, but retains its flattened, polished aspect. It may be a variety of *balthica*. It is less closely related to the true *carlottensis* . . . . page 372

FIGS. 9. *Tellina meropsis* Dall, Recent specimen from San Diego, labeled 277A in the collection at Stanford University. Fig. 9*a*, exterior of left valve; fig. 9*b*, exterior of right valve. The interiors of this specimen are shown on plate 14, figs. 9*a*, 9*b* . . . . page 359

FIG. 10. *Macoma moesta* (Deshayes) variety *acolasta* Dall, specimen No. 135 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Exterior of right valve, length 20 mm. The interior of this specimen is shown on plate 14, fig. 7. Compare also figs. 3 and 4 of this plate . . . . page 371

FIGS. 11. *Macoma nasuta* (Conrad), specimen No. 178 S. D. S. N. H., from locality 74, found with the specimen shown in fig. 10. Fig. 11*a*, exterior of right valve; fig. 11*b*, interior of the same valve; length 53 mm. This species has an unusually heavy hinge for a *Macoma* . . . . page 365

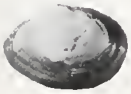
FIG. 12. *Tellina idæ* Dall, specimen No. 179 S. D. S. N. H., from locality 214, middle Pliocene over the Newhall railroad tunnel, Los Angeles Co. Exterior of imperfect left valve, length 52 mm. The sculpture remaining in patches on the other valve is as strong as on the specimen shown in fig. 14*a* . . . . page 358

FIG. 13. *Tellina bodegensis* Hinds, specimen No. 180 S. D. S. N. H., from locality 99, upper Pleistocene terrace west of Newport, Los Angeles Co. Exterior of right valve, length 47 mm . . . . . . page 362

FIGS. 14. *Tellina idæ* Dall, specimen No. 628 in the collection at Stanford University, from the upper San Pedro of Santa Monica. Fig. 14*a*, exterior of right valve; fig. 14*b*, interior of right valve; length 58 mm. The other valve has fine concentric lines as shown in fig. 12 . . . . . page 358

FIGS. 15. *Sanguinolaria nuttallii* Conrad, specimen No. 629 in the collection at Stanford University, from the Pleistocene of San Pedro (Arnold Collection). Fig. 15*a*, hinge of left valve; fig. 15*b*, exterior of left valve; length 88 mm . . . . page 383

FIG. 16. *Apolymetis biangulata* (Carpenter), specimen No. 630 in the collection at Stanford University, from Stanford University locality 206, Las Posas zone, lower Pleistocene, of Barlow Canyon, Ventura Co. Exterior of right valve, length 72 mm . . . . page 363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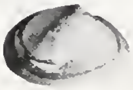
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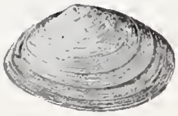
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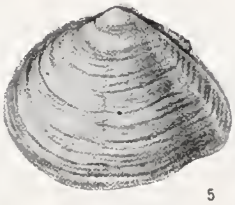
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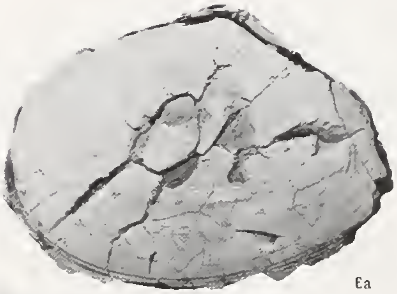
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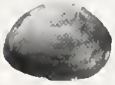
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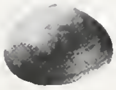
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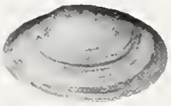
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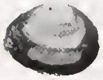
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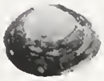
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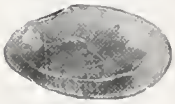
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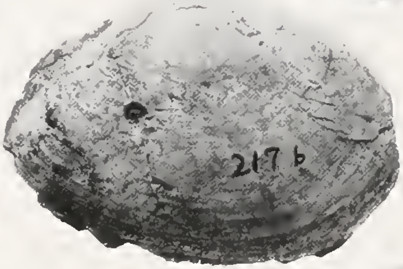
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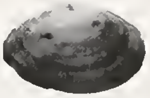
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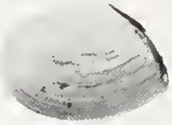
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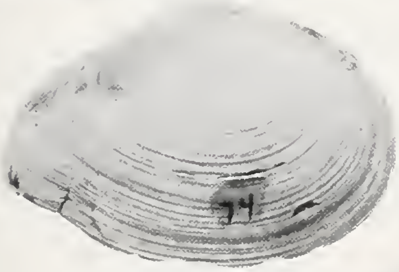
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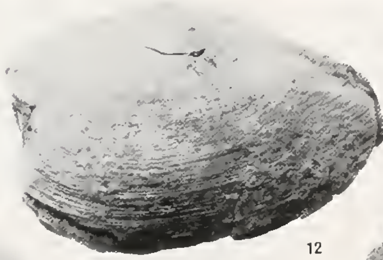
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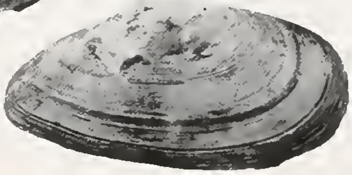
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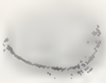
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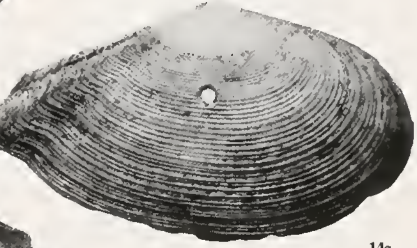
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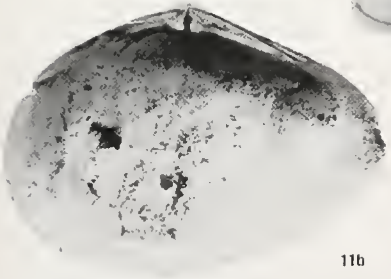
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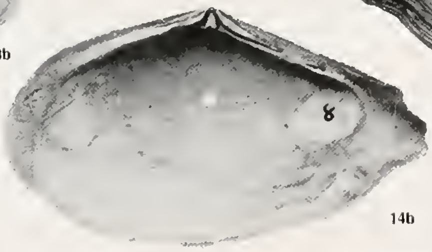
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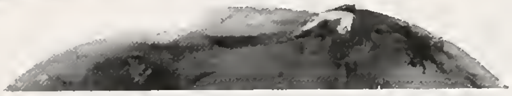
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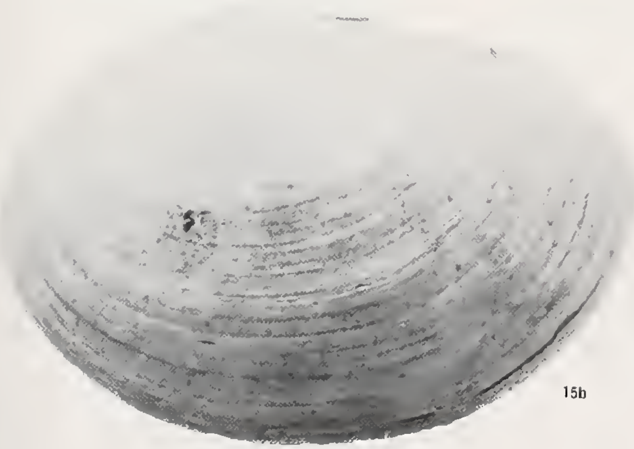
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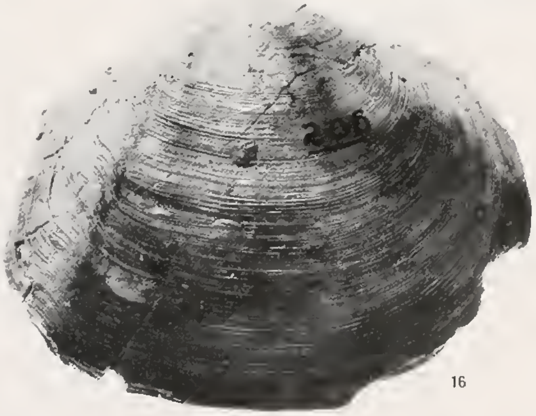
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EXPLANATION OF PLATE 21

FIG. 1. *Siliqua alta* (Broderip and Sowerby), Recent specimen from Swikshak Beach, Alaska, labeled 469A in the collection at Stanford University. Entire interior of the right valve and part of the left, × ⅔, length 118 mm. . . . . page 388

FIGS. 2. *Tagelus californianus* (Conrad), specimen No. 181 S. D. S. N. H., from the San Pedro Pleistocene (Arnold Collection). Fig. 2*a*, exterior of left valve; fig. 2*b*, interior of left valve; length 78 mm. The pallial sinus can be seen reaching two-fifths of the length of the shell . . . . page 384

FIG. 3. *Tagelus californianus* (Conrad), specimen No. 182 S. D. S. N. H., from the San Pedro Pleistocene (Arnold Collection). Interior of right valve, length 76 mm. . . . . page 384

FIG. 4. *Solen sicarius* Gould, specimen No. 183 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Interior of right valve, length 62 mm. The small, somewhat bifid tooth is scarcely visible at the extreme end. . . . . page 385

FIG. 5. *Gari edentula* (Gabb), Recent specimen from San Pedro (25 fathoms), labeled 145A in the collection at Stanford University. Exterior of left valve, × ⅔, length 138 mm. . . . . . page 382

FIG. 6. *Siliqua lucida* (Conrad), specimen No. 184 S. D. S. N. H., from the middle or upper Etchegoin of the General Petroleum Corp. Stiles well near McFarland, Kern Co., depth 3000–18 feet. Exterior of right valve, length 36 mm. . . . . page 389

FIG. 7. *Cryptomya californica* (Conrad), specimen No. 185 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Exterior of right valve, length 23 mm. . . . . page 417

FIGS. 8. *Cryptomya californica* (Conrad), Recent specimen from San Diego, labeled 1707A in the collection at Stanford University. Fig. 8*a*, exterior of left valve; fig. 8*b*, interior of the same valve tipped up to show the chondrophore; length 25 mm . . . . page 417

FIG. 9. *Siliqua* cf. *patula* (Dixon), specimen No. 186 S. D. S. N. H., from the lower Etchegoin of the General Petroleum Corp. Stiles well near McFarland, Kern Co., depth 4450–68 feet. Exterior of left valve, partial length 42 mm. The internal rib can be clearly seen. This form is too large for *lucida*, but is not characteristic of *patula*. The rib is too narrow for *patula* or *alta* and goes too straight across for *patula*. The shape is not right for *alta*. This form is much like the Atlantic *nahantensis*, which may have to be recognized in the California Pliocene. . . . . pages 387, 388

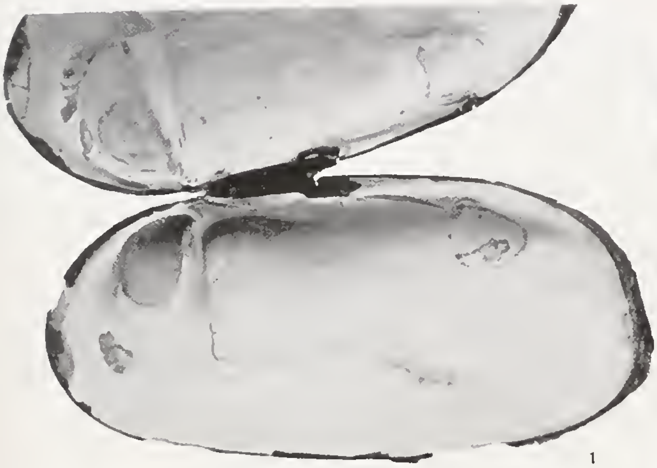
FIGS. 10. *Panope* (*Panomya*) *ampla* (Dall), Recent specimen collected off Orcas Island, Puget Sound, Washington, labeled 198–2A in the collection at Stanford University. Fig. 10*a*, hinge of right valve; fig. 10*b*, exterior of right valve; length 60 mm. . . . . page 426

FIG. 11. *Cryptomya californica* (Conrad), specimen No. 315 S. D. S. N. H., from the Las Posas zone, lower Pleistocene, of Barlow Canyon, Ventura Co. Exterior of left valve, with the hinge of the right valve, which lacks the chondrophore, showing behind; length 28 mm. . . . . . page 417

FIGS. 12. *Panope* (*Panope*) *generosa* Gould, specimen No. 187 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara County. Fig. 12*a*, exterior of left valve; fig. 12*b*, interior of the same valve; both views × ⅔, length 102 mm. This is not a full grown specimen. . . . . page 424

FIG. 13. *Mya* (*Mya*) *arenaria* Linnæus variety *japonica* Jay, specimen No. 188 S. D. S. N. H., from the upper Etchegoin in the So. Calif. Gas Co. well No. 1–4, Sec. 4, T. 28 S., R. 23 E., Kern Co., depth 2877 feet. Exterior of the right valve, with part of the posterior end missing; partial length 70 mm. . . . . page 412

FIGS. 14. *Cryptomya californica* (Conrad), Recent specimen from the same lot as the specimen shown in figs. 8. Fig. 14*a*, exterior of right valve; fig. 14*b*, exterior of left valve; length 16 mm. This variation is very common. It has the shape of the form often called *ovalis*. . . . . page 417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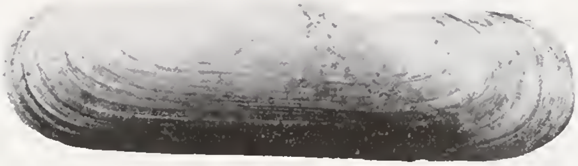
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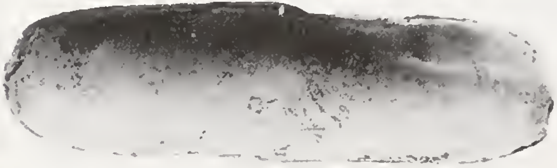
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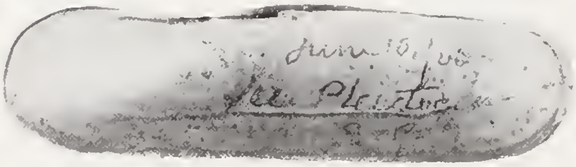
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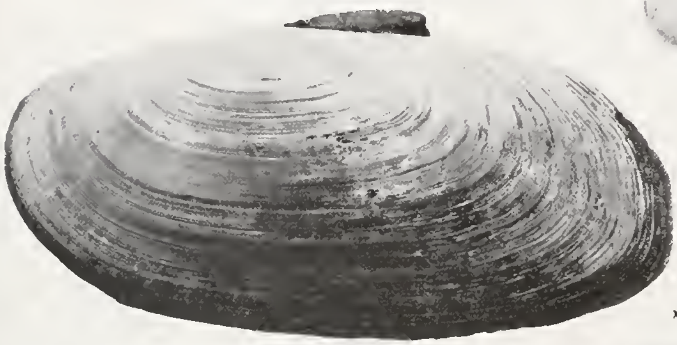
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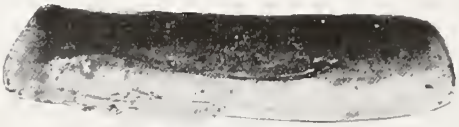
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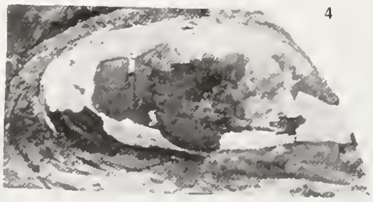
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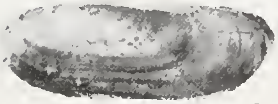
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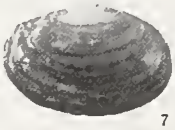
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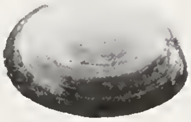
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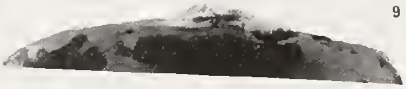
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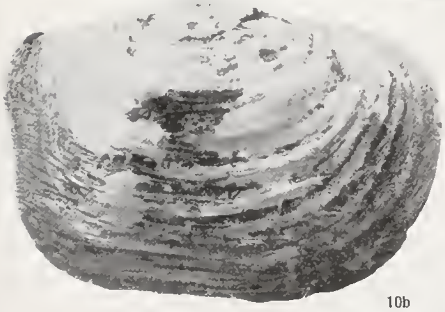
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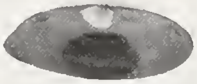
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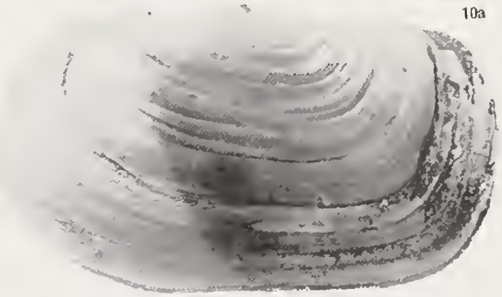
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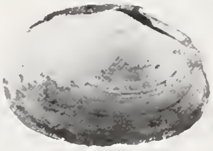
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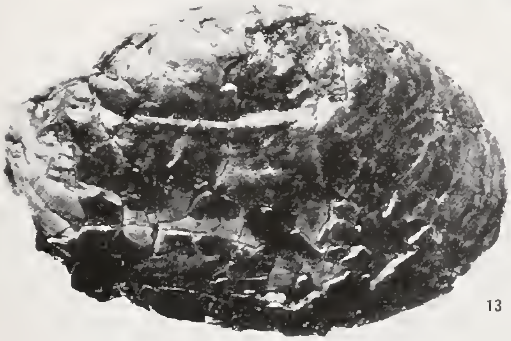
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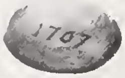

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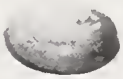
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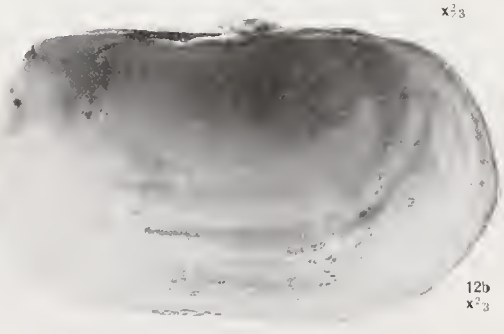
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EXPLANATION OF PLATE 22

FIG. 1. *Dosinia longula* Conrad, holotype, specimen No. 13343 in the U. S. National Museum, from the Miocene of the Salinas Valley, Monterey Co. Exterior of left valve, natural size... page 354

FIG. 2. *Anatina (Raëta ?) transmontana* (Conrad), holotype, specimen No. 13322 in the U. S. National Museum, from "Rancho Triumpho," Los Angeles Co. (near the boundary of Ventura Co. ?), probably Temblor, lower middle Miocene. Exterior of right valve, natural size.. page 409

FIG. 3. *Dosinia montana* Conrad, holotype, specimen No. 13357 in the U. S. National Museum, from the Miocene of the Salinas Valley, Monterey Co. Exterior of left valve, natural size.... page 354

FIG. 4. *Dosinia subobliqua* Conrad, holotype, specimen No. 13356 in the U. S. National Museum, from the Miocene of the Salinas Valley, Monterey Co. Exterior of right valve, natural size.. page 354

FIG. 5. *Pecten (Patinopecten) propatulus* Conrad, holotype, No. 3504 in the U. S. National Museum, from the Miocene of Astoria, Oregon. Exterior of right valve, natural size. The outer surface of this specimen is worn away, but the 16–17 slightly sulcated ribs and the general shape can be seen.. page 192

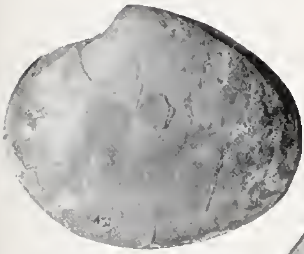
FIGS. 6. *Schizothærus nuttallii* (Conrad) variety *pajaroanus* (Conrad), specimen No. 330 S. D. S. N. H., from the Purisima formation, lower or middle Pliocene, at Point Año Nuevo, San Mateo Co. Fig. 6*a*, posterior view showing the gape; fig. 6*b*, exterior of left valve; length 85 mm.. page 405

FIGS. 7. *Mactra (Mulinia) pallida* Broderip and Sowerby, Recent specimen from Ecuador, labeled A in the collection at Stanford University. Fig. 7*a*, hinge of right valve; fig. 7*b*, exterior of right valve; fig. 7*c*, dorsal view of right valve; length 60 mm. The dorsal margin of the shell is not broken by a ligamental slit, though the shell wall becomes thinner back of the ligament and in poorly preserved specimens may be broken away. The ligament and resilium are both internal, and there is no small shelly ridge separating them as in typical *Mactra* or *Mactrella*.. page 400

FIG. 8. *Schizothærus nuttallii* (Conrad) variety *pajaroanus* (Conrad), holotype, specimen No. 13318 in the U. S. National Museum, from "Pajaro River, Santa Cruz," probably Pliocene. Exterior of right valve, natural size. The shape of this specimen is badly obscured by erosion.. page 405

FIG. 9. *Schizothærus nuttallii* (Conrad), typical variety, Recent specimen, No. 331 S. D. S. N. H., from Totten Inlet, Puget Sound. Posterior view showing the gape, × ½, length of specimen 147 mm., height 115 mm. This figure is to be compared with fig. 6*a*. Other illustrations of this species are given on plate 23, figs. 8*a*, 8*b*, 9...................... page 404

FIGS. 10. *Mactrella exoleta* (Gray), Recent specimen from the coast of Guerero, Mexico, 15 miles south of Rio Balsas, labeled 866–3A in the collection at Stanford University. Fig. 10*a*, right hinge; fig. 10*b*, exterior of right valve; × ⅔, length 118 mm. The shape is somewhat similar to that of *Mactra (Mulinia) pallida*, but the hinge is very different, showing the shelly ridge separating the ligament from the resilium and also showing the weak posterior laminæ. In spite of the shelly ridge, *Mactrella* is probably more distinct from *Mactra* than are *Mulinia* and *Spisula*.. page 402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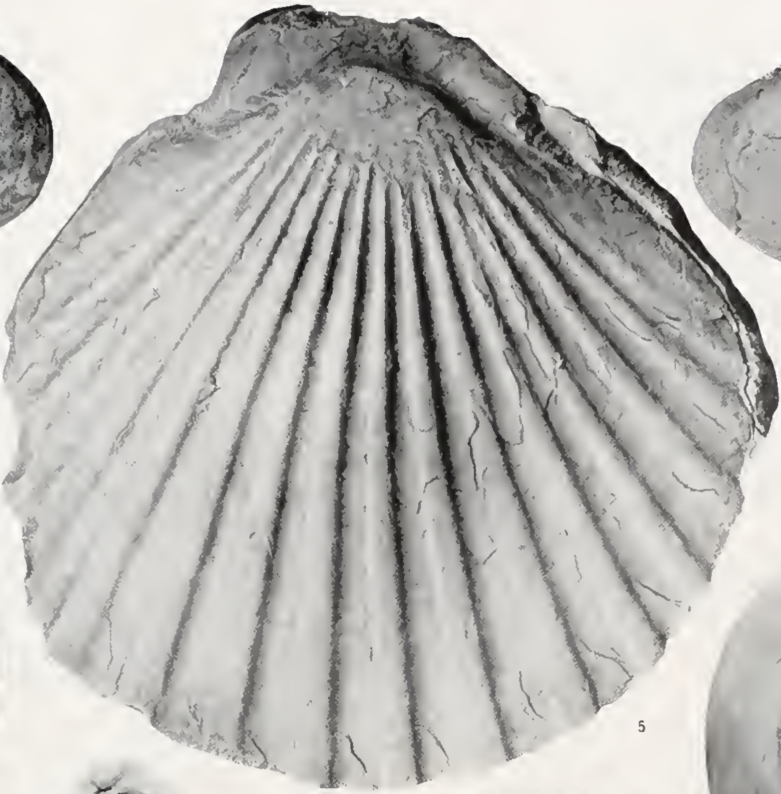
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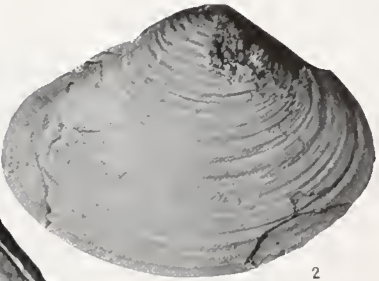
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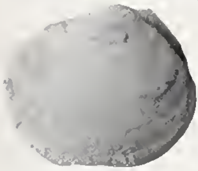
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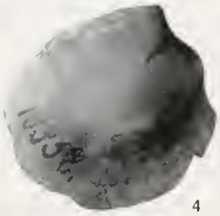
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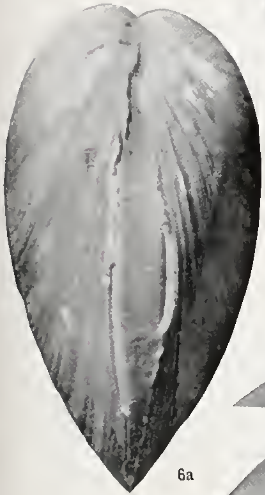
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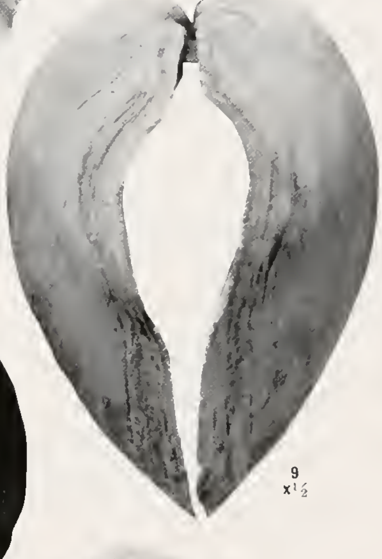
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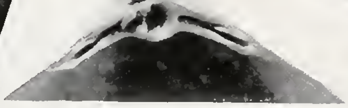
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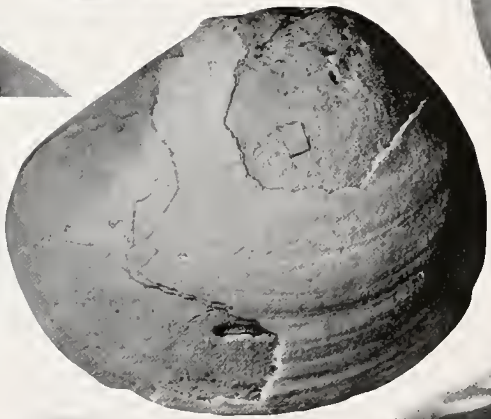
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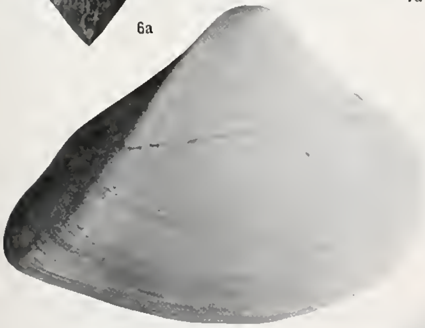
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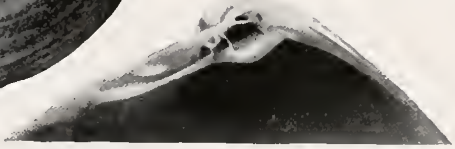
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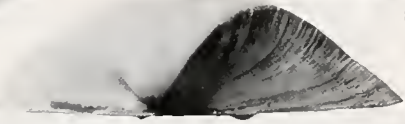
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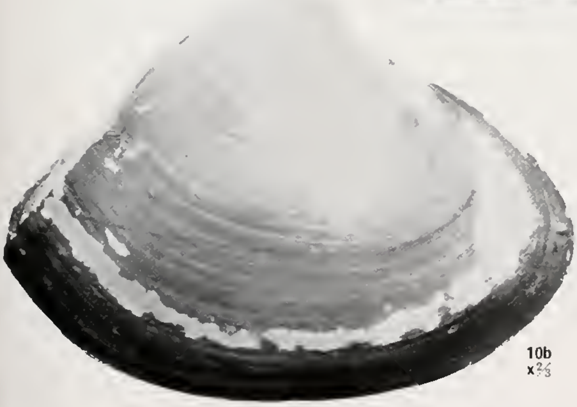
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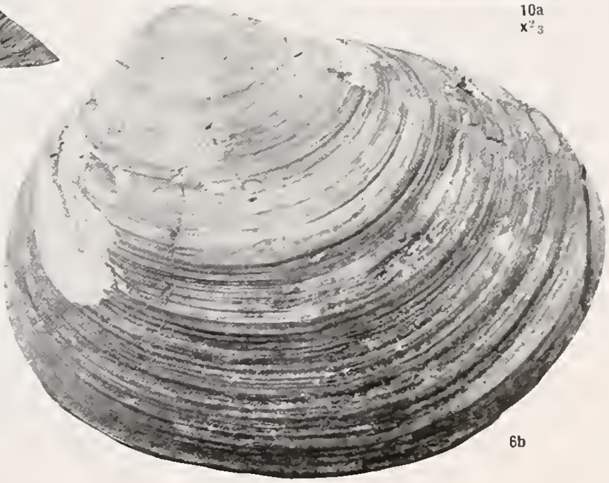
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EXPLANATION OF PLATE 23

FIGS. 1. *Anatina* (*Raëta*) *plicatella* (Lamarck), variety *longior*, new variety, type, specimen No. 192 S. D. S. N. H., from the upper (possibly middle) Miocene of the Superior Oil Company's Ansolabehere well No. 1, northwest of Bakersfield, depth 4525 feet. Fig. 1*a*, exterior of left valve; fig. 1*b*, hinge of the same valve; length 40 mm. . . . . page 408

FIGS. 2. *Mactra* (*Mactra*) *orthomorpha*, new species, type, specimen No. 193 S. D. S. N. H., from the upper Etchegoin of a well drilled for oil near Tipton, Tulare Co. Fig. 2*a*, exterior of right valve; fig. 2*b*, same view with a fragment of another specimen of about the same size fitted over it to indicate the shape; fig. 2*c*, hinge of the right valve; partial length 36 mm., restored 39 mm. The shelly ridge of typical *Mactra* is faintly visible above and to the right of the chondrophore . . . . page 391

FIGS. 3. *Mactra* (*Spisula*) *albaria* Conrad, specimen No. 189 S. D. S. N. H., from a depth of 4575 feet in the same well in which the specimen shown in fig. 1 was found, upper (possibly middle) Miocene. Fig. 3*a*, exterior of right valve; fig. 3*b*, hinge of the same valve; length 30 mm. . page 395

FIG. 4. *Mactra* (*Spisula*) *catilliformis* (Conrad), specimen No. 196 S. D. S. N. H., from the *Cryptomya californica* zone, lower Etchegoin, of the Petroleum Eastern Production Company's well K. C. L.-B. No. 3, Fruitvale district, northwest of Bakersfield, depth 3229 feet. Exterior of right valve, length 58 mm. The beaks of this specimen are crushed forward and pointed, as is often the case with well-core specimens. The posterior is slightly broader than shown in the illustration. . . . . page 398

FIGS. 5. *Anatina* (*Raëta*) *undulata* (Gould), specimen No. 631 in the collection at Stanford University, from the Palos Verdes terrace at San Pedro, upper Pleistocene. Fig. 5*a*, exterior of left valve; fig. 5*b*, hinge of right valve; fig. 5*c*, hinge of left valve; length 80 mm . . . . page 407

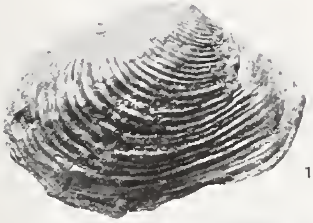
FIG. 6. *Mactra* (*Mactra*) *orthomorpha*, new species, paratype, No. 194 S. D. S. N. H., found with the type. Hinge of left valve, length 21 mm. This specimen and the one shown in fig. 7 illustrate the single long thin laterals of the left valve. The mactroid ridge hardly shows on the specimens and is not visible in the illustrations. . . . . page 391

FIG. 7. *Mactra* (*Mactra*) *orthomorpha*, new species, paratype, No. 195 S. D. S. N. H., found with the type. Hinge of left valve, length about 21 mm . . . . page 391

FIGS. 8. *Schizothærus nuttallii* (Conrad), specimen No. 198 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Fig. 8*a*, hinge of right valve; fig. 8*b*, exterior of right valve; length 128 mm. . . . . page 404

FIG. 9. *Schizothærus nuttallii* (Conrad), specimen No. 199 S. D. S. N. H., from the same locality as the last. Hinge of left valve, length of specimen 96 mm. The posterior gape of this species is shown on plate 22, fig. 9. . . . . page 404

FIG. 10. *Mactra* (*Spisula*) *catilliformis* (Conrad), specimen No. 197 S. D. S. N. H., from the same well as the specimen shown in fig. 4, depth 3230 feet. Hinge of large right valve, fragment shown 52 mm. long . . . . page 398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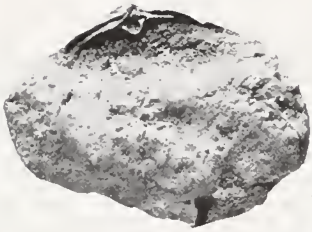
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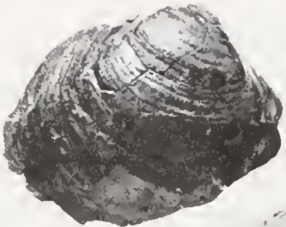
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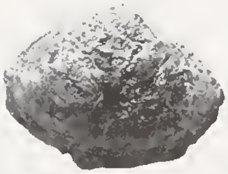
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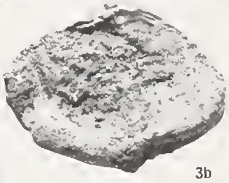
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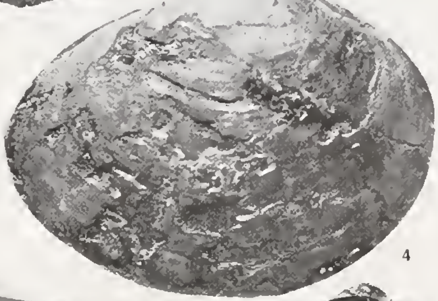
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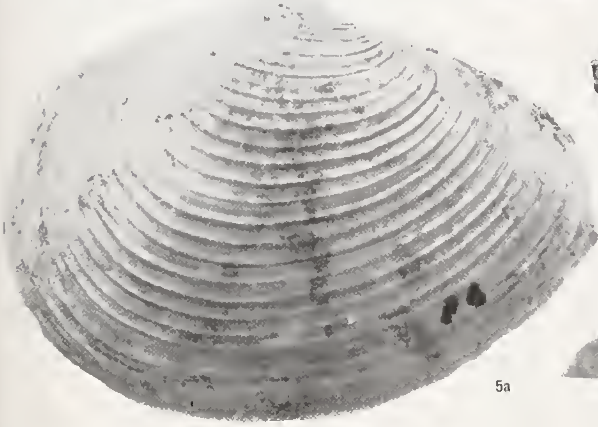
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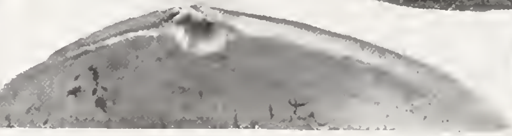
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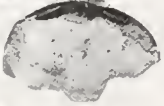
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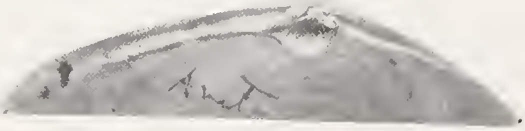
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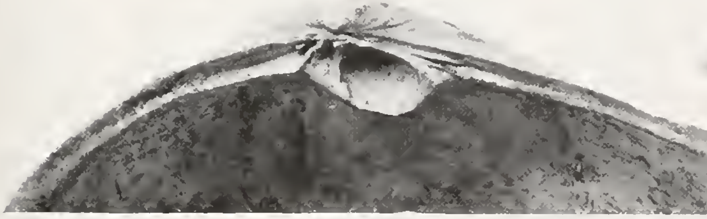
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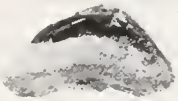
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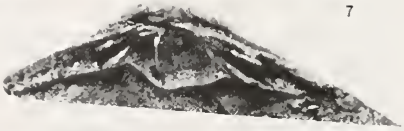
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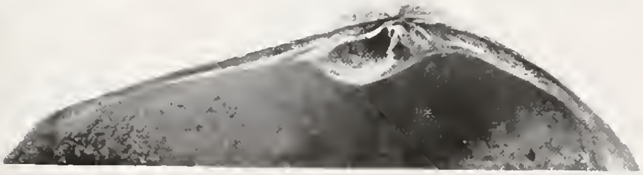
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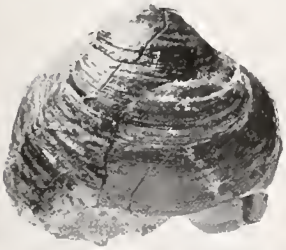
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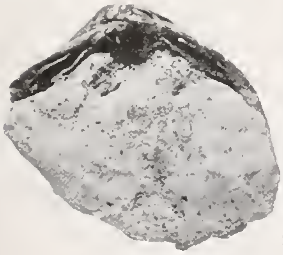
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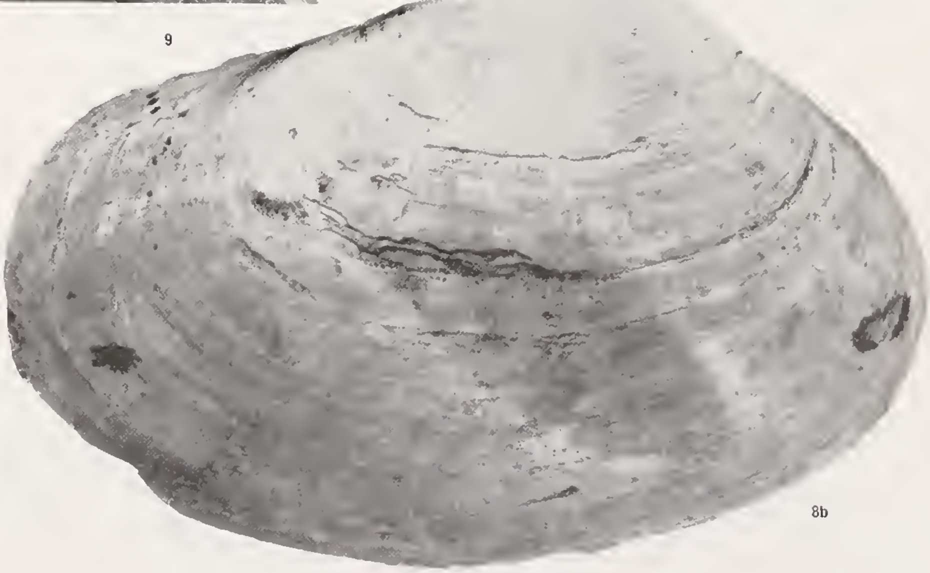

8b

EXPLANATION OF PLATE 24

FIGS. 1. *Pholadidea (Pholadidea) penita* (Conrad), specimen No. 200 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Fig. 1*a*, exterior of left valve; fig. 1*b*, interior of left valve; length 81 mm. This species when young has the shape of a *Pholas*. It is not unlikely that the separation between *Pholadidea* and *Pholas* has been overemphasized.. page 434

FIG. 2. *Pholas (Zirfaea) gabbi* (Tryon), specimen No. 201 S. D. S. N. H., from the middle Etchegoin of the General Petroleum Corp. Stiles well No. 1 near McFarland, Kern Co., California, depth 3900–18 feet. Exterior of right valve, length 66 mm.......................... page 432

FIGS. 3. *Mya (Platyodon) cancellata* Conrad, specimen No. 202 S. D. S. N. H., from locality 40, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co. Fig. 3*a*, hinge and interior of left valve; fig. 3*b*, exterior of left valve; length 56 mm.......................... page 415

FIG. 4. *Bankia setacea* (Tryon), Recent specimen from Departure Bay, British Columbia, labeled 386–4A in the collection at Stanford University. Fragment of the tube secreted by the animal, length 80 mm. The shell of this species, found in Recent specimens within the tube, resembles a very small, thin, shortened Pholad. *Bankia* is distinguished from *Teredo* only by accessory semi-hard parts.. Not in text

FIG. 5. *Aletes squamigerus* Carpenter, variety *pennatus* (Mörch), specimen so identified and reported by Mr. T. S. Oldroyd from the lower San Pedro series (i. e., San Pedro formation) of the Nob Hill cut, San Pedro; specimen in the collection at Stanford University marked 155A, length 79 mm. The typical variety of this species as identified by Mr. Oldroyd has rough longitudinal striations. This form might easily be mistaken for a Teredo tube such as shown in fig. 4; but it is a gastropod related to *Vermetus*, *Serpulorbis*, and *Siliquaria*. As most of the distinctions in this group depend on opercula, it is obvious that identifications of fossils are usually very uncertain. The occasional shelly partition, one of which is shown in the photograph, will sometimes help to distinguish this group from Teredo tubes page 777

FIG. 6. *Cerithidea californica* (Haldemann), specimen No. 203 S. D. S. N. H., from the Pleistocene of San Pedro; length 24 mm.. page 763

FIG. 7. *Cerithidea californica* (Haldemann), specimen No. 204 S. D. S. N. H., from the Pleistocene of San Pedro; length 29 mm.. page 763

FIG. 8. *Bittium (Semibittium) rugatum* Carpenter, specimen No. 205 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; × 2, length 10 mm... page 762

FIG. 9. *Bittium (Stylidium) eschrichtii* (Middendorff), Recent specimen from Oregon or Washington, labeled 108–3A in the collection at Stanford University; × 2, length 14 mm........... page 761

FIG. 10. *Olivella pedroana* (Conrad), specimen No. 206 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; length 11 mm. Unfortunately the apex of the figure was trimmed off during the preparation of the plate.................... page 626

FIG. 11. "*Cerithium*" *simplicius*, new species, type, No. 207 S. D. S. N. H., from the middle Pliocene of locality 217*b*, Holser Canyon, north of the Santa Clara Valley, Los Angeles Co.; length of incomplete specimen 32 mm.. page 757

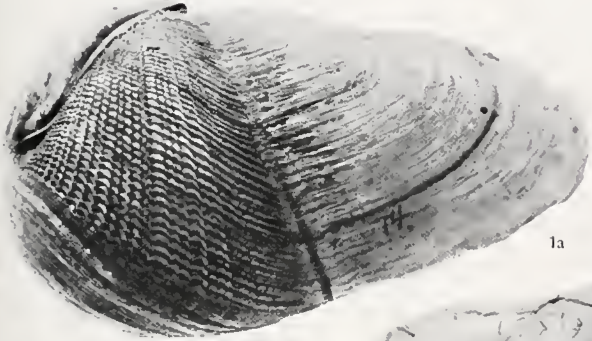
FIG. 12. *Acteon (Rictaxis) painei* Dall variety *grandior*, new variety, type, No. 208 S. D. S. N. H., from the middle Pliocene of locality 217*c*; length 18 mm.................................. page 444

FIG. 13. *Retusa (Acteocina) culcitella* (Gould), specimen No. 209 S. D. S. N. H., from the Las Posas zone, lower Pleistocene of Harmon Canyon, Ventura Co.; length of incomplete specimen 19 mm.. page 447

FIG. 14. *Bittium (Lirobittium) asperum* (Gabb) variety *dilatatum*, new variety, type, No. 210 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, north of the Santa Clara Valley, Los Angeles Co.; × 5, length of somewhat incomplete specimen 6 mm.......... page 760

FIG. 15. *Olivella biplicata* (Sowerby), specimen No. 211 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara County; length 26 mm.................. page 625

(*Continued on page 933*)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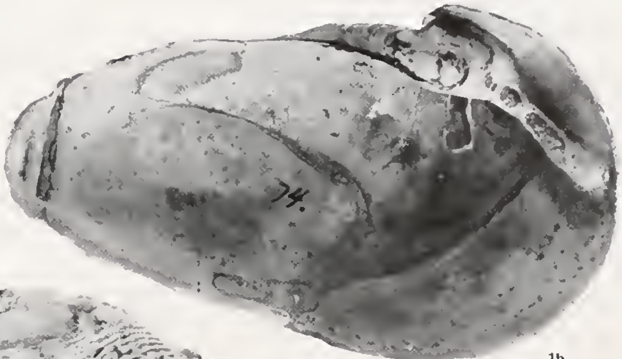
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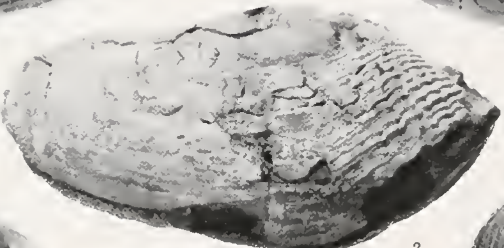
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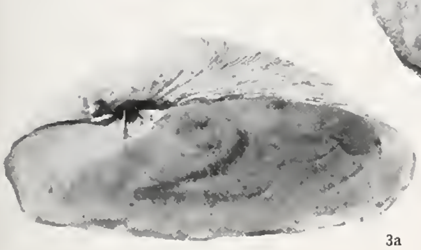
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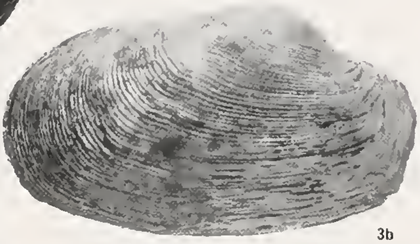
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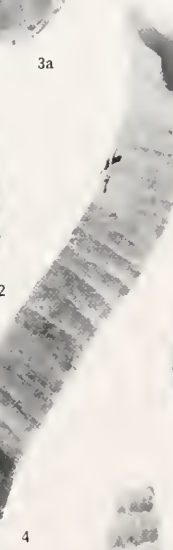
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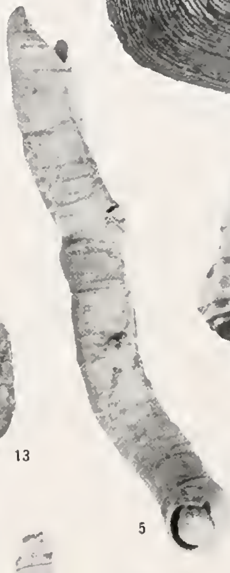
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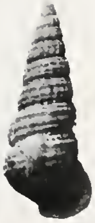
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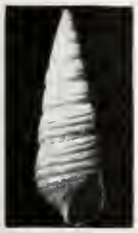
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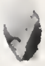
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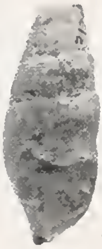
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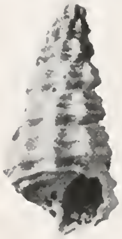
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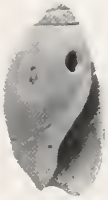
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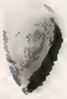
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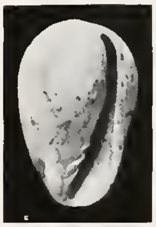
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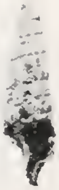
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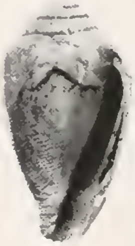
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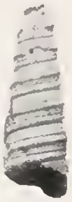
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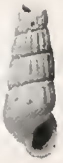
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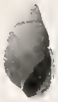
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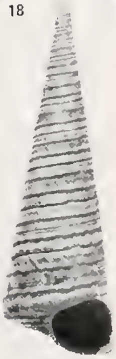
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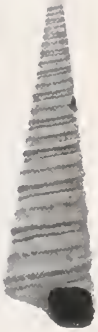
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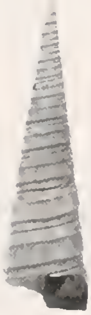
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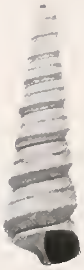
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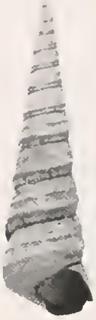
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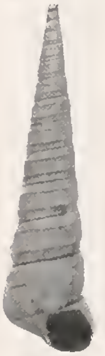
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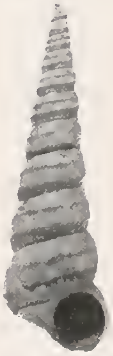
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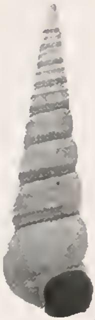
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EXPLANATION OF PLATE 24—(Continued)

FIG. 16. *Melampus olivaceous* Carpenter, specimen No. 212 S. D. S. N. H., from the upper San Pedro (Palos Verdes) of San Pedro; length 13 mm. The plications present on both lips are not clearly shown . . . . page 461

FIG. 17. *Hyalina (Cystiscus) jewettii* (Carpenter), specimen No. 213 S. D. S. N. H., from the lower San Pedro series of San Pedro, lower Pleistocene; × 5, length 5 mm. This specimen was picked at random from a lot identified by Mr. Oldroyd as *nanella*. The lower three plications are strong, the fourth barely visible in the photograph, and the upper ones hardly discernible under a glass, as in the living *jewettii* . . . . page 630

FIG. 18. *Terebra (Strioterebrum) albocincta* (Carpenter) variety *pedroana* Dall, Recent specimen from San Diego, labeled 2133A in the collection at Stanford University; length 22 mm. This specimen belongs to the variation with weaker nodes on the anal fasciole . . . . page 469

FIG. 19. *Terebra (Strioterebrum)* cf. *dislocata* (Say), specimen No. 214 S. D. S. N. H., from locality 249, lower Pleistocene about a third of a mile north of the corner of Kalorama and Poli Streets in the city of Ventura, Calif.; length 25 mm. The reproduction of this figure is poor. The axial ribs are nearly as strong as the elongate nodes on the anal fasciole. In *albocincta* variety *pedroana* the axial ribs are usually not so strong as on this specimen; and in the few cases where they are, the nodes on the anal fasciole are much stronger . . . . page 468

FIG. 20. *Epitonium (Opalia) varicostatum* (Stearns), specimen No. 215 S. D. S. N. H., from the middle Pliocene of Pacific Beach, San Diego; length 30 mm. (spire defective) . . . . page 853

FIG. 21. *Conus californicus* Hinds, specimen No. 216 S. D. S. N. H., from the Las Posas zone, lower Pleistocene of locality 235, Santa Paula Quadrangle, Ventura Co.; length 33 mm . . . . . . page 472

FIG. 22. *Turritella vanvlecki* Arnold, specimen No. 217 S. D. S. N. H., from the middle Pliocene of locality 217*a*, Holser Canyon north of Santa Clara Valley, Los Angeles Co.; length of incomplete specimen 26 mm. This specimen shows the characters of the species more clearly than the specimens hitherto illustrated. Sometimes the central ridge is not so prominent . . . . page 773

FIG. 23. *Turbonilla (Pyrgolampros) idae* Oldroyd, specimen No. 316 S. D. S. N. H., from locality 247, a little north of locality 249 (see fig. 19), lower Pleistocene of Ventura Co.; × 3, length 7 mm . . . . page 869

FIG. 24. *Terebra (Strioterebrum) albocincta* (Carpenter) variety *pedroana* Dall, Recent specimen from the same lot as the specimen shown in fig. 18; length 22 mm. This specimen is a more strongly sculptured variation . . . . page 469

FIG. 25. *Odostomia* cf. *(Evalea) phanea* Dall and Bartsch, specimen No. 218 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; × 3, length 4.5 mm. This is a young specimen. A larger specimen perhaps of the same species is shown on plate 32, fig. 20 . . . . page 875

FIGS. 26, 27. *Turritella jewettii* Carpenter, specimens Nos. 219 and 220 S. D. S. N. H., from the lower San Pedro of San Pedro, lower Pleistocene; lengths 70 mm. and 49 mm., respectively . . . . page 770

FIGS. 28–34. *Turritella cooperi* Carpenter, specimens Nos. 221 to 227 S. D. S. N. H., from the upper San Pedro series (Palos Verdes), upper Pleistocene of Crawfish George's, San Pedro; lengths 44 mm., 42 mm., 35 mm., 42 mm., 47 mm., 47 mm., and 42 mm., respectively. This series of specimens, all from a single locality, is shown to illustrate the variability of this species. The specimen shown in fig. 28 has stronger ribs like the form described by Dall as *mariana*. *T. jewettii* has a wider apical angle . . . . page 771

EXPLANATION OF PLATE 25

Figs. 1. *Surculites* (*Pseudotoma*) *intortus* (Brocchi), specimen No. 632 in the collection at Stanford University, from the Scaldisien Pliocene of Antwerp, Belgium. Specimen apparently identified by Cossmann. Fig. 1*a*, apertural view, outer lip slightly defective; fig. 1*b*, side view showing the nature of the posterior notch by the growth lines; length 62 mm . . . page 500

Fig. 2. *Surculites* (*Surculites*) *wynootcheensis* (Weaver), specimen No. 633 in the collection at Stanford University, from the Miocene of Black Creek Bluffs, Wynootche River, Washington; length 44.5 mm. It is well to compare this member of the typical subgenus with what appear to be the derivatives of the typical subgenus figured on each side of it . . . . . pages 493, 500

Fig. 3. *Surculites* (*Megasurcula*) *carpenterianus* (Gabb) variety *cooperi* (Arnold), type, specimen No. 426 in the collection at Stanford University; length 64 mm . . . . page 499

Figs. 4. *Surculites* (*Megasurcula*) *carpenterianus* (Gabb), typical variety, specimen No. 228 S. D. S. N. H., from Stanford University locality 643, Las Posas zone east of Sexton Canyon, Ventura Co.; length 63 mm . . . . page 497

Fig. 5. *Surculites* (*Megasurcula*) *remondii* (Gabb), specimen No. 229 S. D. S. N. H., from the lower Pliocene of locality 216 east of Fernando Pass, Los Angeles Co.; length 40 mm . . . . page 495

Fig. 6. *Surculites* (*Megasurcula*) *remondii* (Gabb), specimen No. 230 S. D. S. N. H., found with the specimen shown in fig. 5; length 35 mm . . . . page 495

Fig. 7. *Surculites* (*Megasurcula*) *remondii* (Gabb), specimen No. 634 in the collection at Stanford University, from Elsmere Canyon, northeast of Fernando Pass, Los Angeles Co.; length 30 mm . . . . page 495

Figs. 8. *Surculites* (*Megasurcula*) *remondii* (Gabb), Recent specimen from San Pedro, labeled 550A in the collection at Stanford University; length 35.5 mm. This specimen has an operculum with a terminal nucleus. It is more like the Pliocene type specimen of this species in shape than are the specimens shown in figs. 5, 6, and 7, which are more like the form *fernandoanus* (Arnold) . . . . page 495

Figs. 9. *Turricula flammea* Schumacher, type species of the genus *Turricula*, Recent specimen from Ceylon, labeled 3857A in the collection at Stanford University; length 72 mm . . . . page 486

Figs. 10. *Clavatula* (*Knefastia*) *tuberculifera* (Broderip and Sowerby), Recent specimen from the Gulf of California, labeled 717A in the collection at Stanford University; length 61 mm. The form shown in figs. 15 may be a more common variety of this species . . . . page 485

Figs. 11. *Turricula maculosa* (Sowerby), Recent specimen from the Gulf of California, labeled 720A in the collection at Stanford University; length 36 mm. This is an extreme form for the genus *Turricula* leaning towards *Spirotropis* . . . . page 488

Figs. 12. *Perrona nifat* (Adanson in Bruguière), type of the group *Pusionella* Gray, a minor subdivision of *Perrona*, Recent specimen from Corsica, labeled 3421A in the collection at Stanford University; length 52 mm. This species is figured here to illustrate the smooth-whorled, shallow-notched extreme of the *Clavatula-Perrona* series . . . . page 612

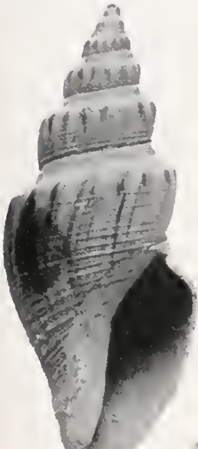
Figs. 13. *Perrona obesa* (Reeve), a more typical species of *Perrona*, Recent specimen from Gambia, northwest Africa, labeled 3581A in the collection at Stanford University; length 36 mm . . . . . . page 612

Figs. 14. *Clavatula* (*Clavatula*) *coronata* (Chemnitz) Lamarck, variety *bimarginata* (Lamarck), Recent specimen from Gorée, west Africa, labeled 3840A in the collection at Stanford University; length 47 mm. This is a variety of the type species of the genus *Clavatula*, showing the relationship with the subgenus *Knefastia* . . . . pages 483, 484

Figs. 15. *Clavatula* (*Knefastia*) *olivacea* (Sowerby), Recent specimen from the Gulf of California, labeled 716A in the collection at Stanford University; length 51 mm . . . . page 484

Figs. 16. *Clavatula* (*Clavatula*) *coronata* (Chemnitz) Lamarck, typical variety, Recent specimen from southern Africa, labeled 703A in the collection at Stanford University; length 29 mm. This is the type species of the genus *Clavatula* . . . . pages 482, 484

(*Continued on page 937*)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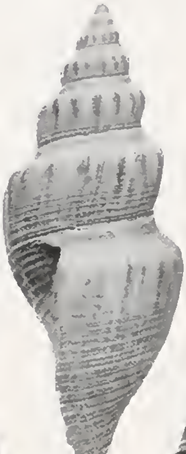
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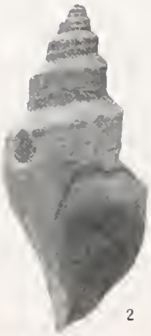
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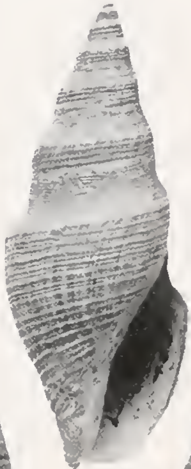
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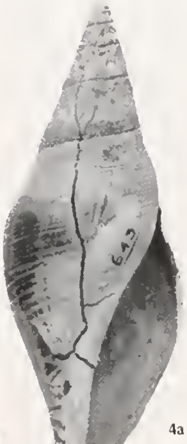
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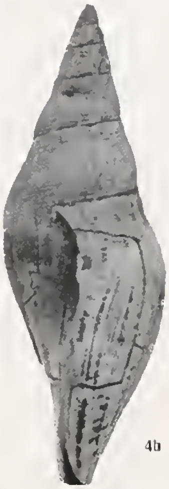
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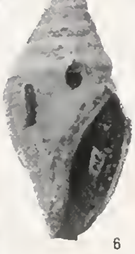
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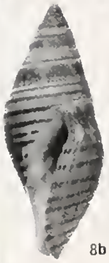
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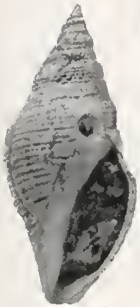
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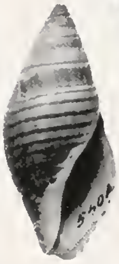
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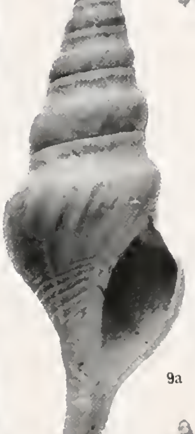
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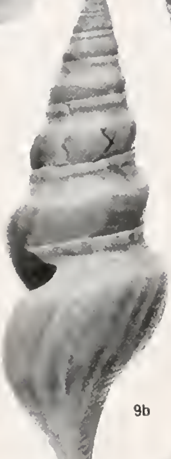
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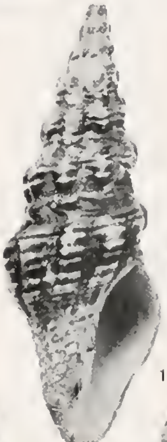
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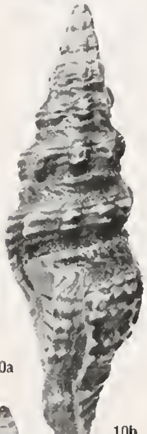
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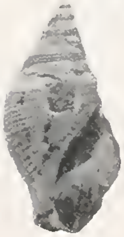
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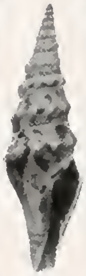
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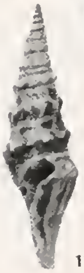
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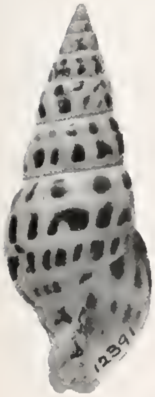
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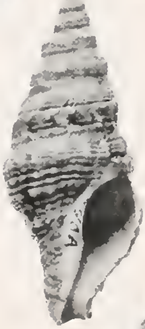
13a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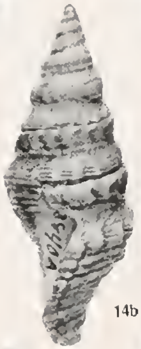
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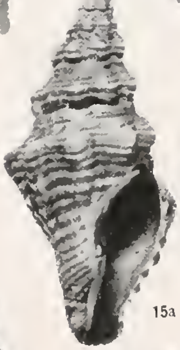
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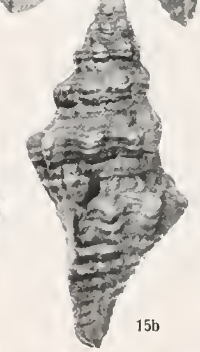
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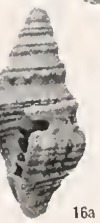
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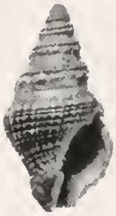
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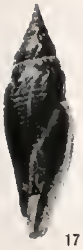
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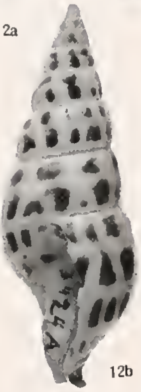
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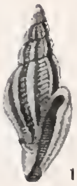
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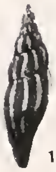
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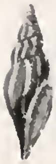
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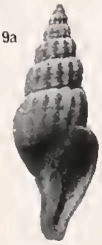
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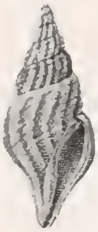
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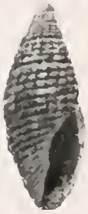
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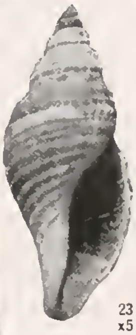
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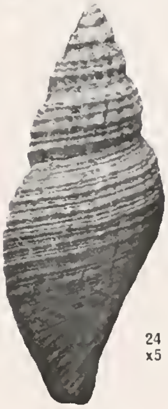
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x5

EXPLANATION OF PLATE 25—(Continued)

FIG. 17. *Genota mitriformis* (Wood), Recent specimen from Sénégal, northwest Africa, labeled 3615A in the collection at Stanford University; length 32 mm. This species is the type of *Genota* . . . . page 502

FIG. 18. *Mangelia striolata* Risso [= *M. attenuata* (Montagu)], reproduction of Risso's original figure, pl. 8, fig. 101, of the type species of *Mangelia*, from the Mediterranean; × $^{9}/_{5}$, length as indicated by Risso 13 mm . . . . page 585

FIGS. 19. *Mangelia villiersii* (Michaud) [= *M. attenuata* (Montagu)], reproduction of Kiener's figures of *Pleurotoma villiersii* Michaud, from the Mediterranean; slightly enlarged according to Kiener's measurement, 7 lines (= 18 mm.) . . . . page 585

FIG. 20. *Lora oldroydi* (Arnold) [= ? *Lora declivis* (Lovén) variety *ecarinata* (Sars)], type specimen, No. 429 in the collection at Stanford University, from the lower San Pedro series, lower Pleistocene of San Pedro, Calif.; × 2, length 16 mm . . . . page 530

FIG. 21. *Ishnula menardiana* (Risso), reproduction of Risso's original figure, × 2, length indicated by Risso 15 mm . . . . page 593

FIG. 22. *Mangelia* (*Mitromorpha*) *gracilior* (Hemphill in Tryon), Recent specimen from Monterey in the Oldroyd collection at Stanford University, labeled 546A (lower left-hand corner of box); × 5, length 5.5 mm. This specimen may be part of the original type material; and if so, it shall be considered the lectotype. It is not unlikely that the names *gracilior* and *intermedia* should be both submerged into the synonymy of *interfossa* . . . . page 597

FIG. 23. *Daphnella clathrata* Gabb, Recent specimen from San Pedro, labeled 461A in the collection at Stanford University; × 5, length 8.2 mm . . . . page 542

FIG. 24. *Daphnella clathrata* Gabb, specimen from the same lot as the specimen shown in fig. 23; × 5, length 10.75 mm . . . . page 542

EXPLANATION OF PLATE 26

FIG. 1 *Clavus* (*Clavus*) *flammulatus* Montfort, reproduction of one of Kiener's figures of *Pleurotoma echinata* Lamarck; length according to Kiener 21 lines (= 52 mm.). If by any chance this is not the species figured by Montfort for the type of *Clavus*, it certainly has all the essential characters of that species and will represent the genotype.................... page 574

FIGS. 2. *Clavus* (*Clavus*) *unimaculatus* (Sowerby), Recent specimen from the Gulf of California, labeled 699A in the collection at Stanford University; length 50 mm......................... page 575

FIGS. 3. *Clavus* (*Clathrodrillia*) *gibbosus* (von Born), reproduction of von Born's original figures in the Testacea, reproduction natural size, original specimen given as 1 poll, 10 lines long (= about 50 mm.).. page 579

FIGS. 4. *Clavus* (*Clathrodrillia*) *flavidulus* (Lamarck), Recent specimen from Hong Kong, labeled 3131A in the collection at Stanford University, length 57 mm. The operculum has a terminal nucleus.. page 579

FIGS. 5. *Pseudomelatoma penicillata* (Carpenter), Recent specimen from Point Abreojos, Lower California, labeled 429–1A in the collection at Stanford University; length 33 mm. The operculum with a terminal nucleus is visible in fig. 5*a*. Fig. 5*b* shows the side view and the shape of the posterior notch.. page 560

FIGS. 6. *Clavus* (*Crassispira*) *bottæ* (Valenciennes in Kiener), reproduction of Kiener's original figures of a specimen from Mazatlan, reproduction natural size; length according to Kiener 22 lines (= about 54 mm.). It is highly desirable that specimens from Mazatlan be identified with these figures, unless Kiener made a mistake in locality................ page 580

FIG. 7. *Clavus* (*Cymatosyrinx*) *lunatus* (Lea), reproduction of Lea's original figure, Miocene of Virginia; reproduction natural size. This figure and figs. 3 show that *Clathrodrillia* is scarcely to be distinguished from *Cymatosyrinx*.. page 575

FIG. 8. *Clavus* (*Cymatosyrinx*) *hemphilli* (Stearns), Recent specimen from Scammon's Lagoon, Lower California, labeled 439 in the collection at Stanford University; × 2, length 12 mm. This species has been divided up into a large number of forms that are certainly no more than varieties and are probably of no significance...................................... page 577

FIG. 9. *Clavus* (*Crassispira*) *montereyensis* (Stearns), Recent specimen from San Diego, labeled 436 in the collection at Stanford University; × 2, length 15 mm. The band above the fasciole as in *Clavatula* and *Pseudomelatoma* distinguishes the subgenus *Crassispira* from the other groups of *Clavus*.. page 581

FIG. 10. *Clavus* (*Crassispira*) sp. indet., perhaps new, specimen No. 231 S. D. S. N. H., from the middle Pliocene of locality 217*b*, Holser Canyon, Los Angeles Co.; length 20 mm............ page 582

FIG. 11. *Clathurella conradiana* Gabb, specimen No. 236 S. D. S. N. H., from the Santa Barbara zone, upper Pliocene of locality 218, Sulphur Canyon east of South Mt., Ventura Co.; × 5, length 10 mm.. page 606

FIG. 12. *Moniliopsis graciosana* (Arnold), specimen No. 635 in the collection at Stanford University, from the Pliocene 4 mi. west of Santa Barbara (if the label is to be trusted); length 19 mm. This specimen is apparently the young of the gerontic form shown in fig. 13.......... page 569

FIG. 13. *Moniliopsis graciosana* (Arnold), specimen No. 636 in the collection at Stanford University, from the same locality as the specimen shown in fig. 12; length 28 mm... .... page 569

FIGS. 14. *Clavus* (*Clathrodrillia*) *coalingensis* (Arnold), specimen No. 232 S. D. S. N. H., from locality 207, lower Pliocene of Elsmere Canyon, Los Angeles Co. Fig. 14*a*, apertural view; fig. 14*b*, side view showing roughly the notch; length 31 mm.......................... page 580

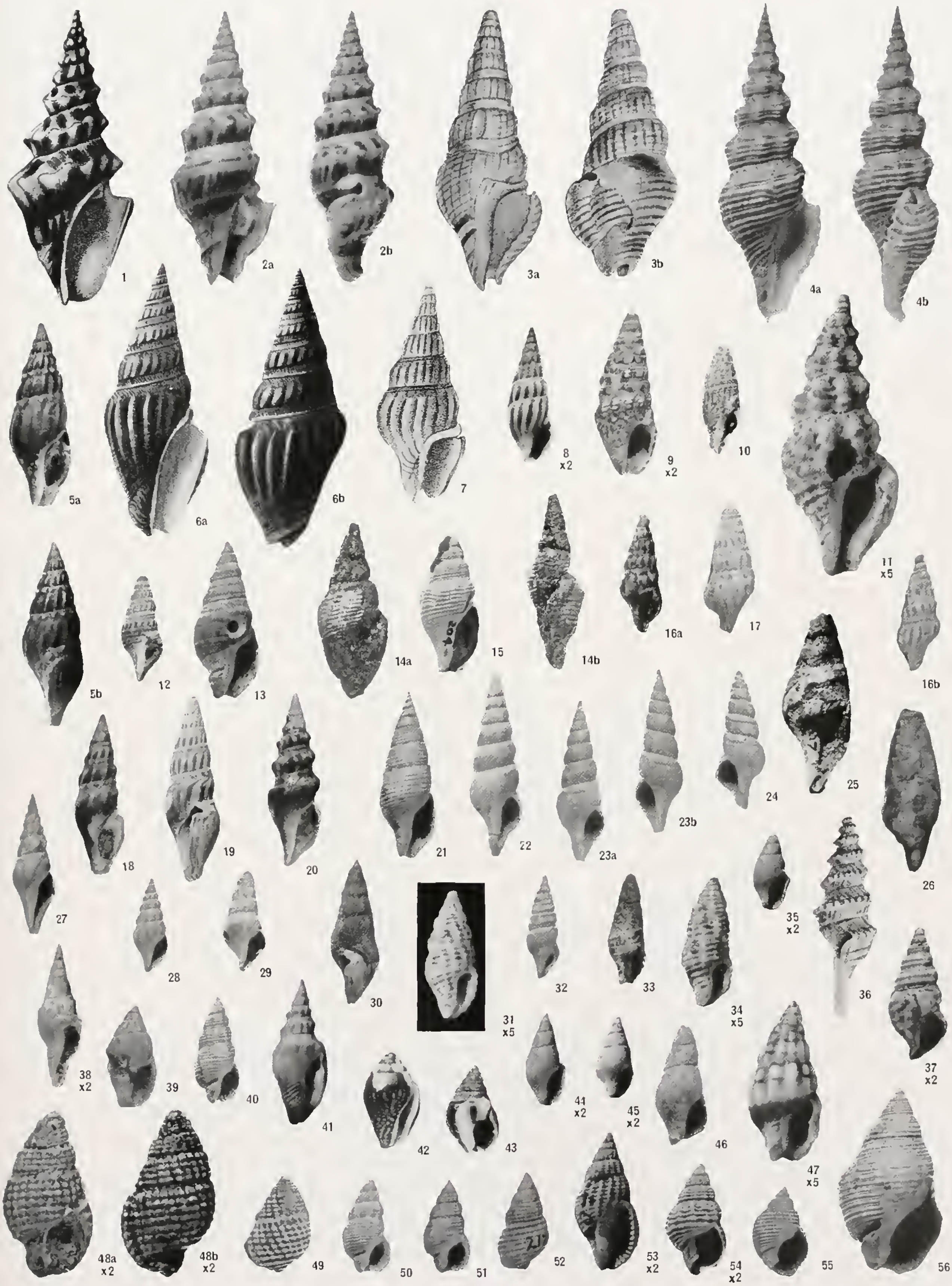
FIG. 15. *Clavus* (*Clathrodrillia*) *coalingensis* (Arnold), specimen No. 233 S. D. S. N. H., from locality 204, lower Pliocene of Elsmere Canyon, length 25 mm.......................... page 580

FIGS. 16. *Clavus* (*Cymatosyrinx*) *pallidus* (Sowerby), specimen No. 234 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, Los Angeles Co.; length 21 mm. Fig. 16*a* shows rather poorly the strong callus at the top of the inner lip.......................... page 576

FIG. 17. *Clavus* (*Cymatosyrinx*) *pallidus* (Sowerby), specimen No. 235 S. D. S. N. H., found with the specimen shown in figs. 16, length 23 mm.. page 576

FIG. 18. *Pseudomelatoma penicillata* (Carpenter), Recent specimen from Scammon's Lagoon, Lower California, labeled 429–3A in the collection at Stanford University; length 29 mm. This specimen is slenderer than the typical form, and shows a tendency to vary toward the variety *semiinflata* and *P. torosa*.. page 560

(*Continued on page 940*)


1
2a
2b
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44 x2
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47 x5
48a x2
48b x2
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53 x2
54 x2
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56

EXPLANATION OF PLATE 26—(Continued)

FIG. 19. *Pseudomelatoma penicillata* (Carpenter) variety *semiinflata*, new variety, type, specimen No. 237, from the upper Pleistocene, Palos Verdes, of Santa Monica; length 34 mm........ page 561

FIG. 20. *Pseudomelatoma torosa* (Carpenter), Recent specimen from Monterey, labeled 428–3A in the collection at Stanford University; length 31 mm.................................... page 562

FIG. 21. *Moniliopsis incisa* (Carpenter), typical variety, specimen No. 238 S. D. S. N. H., from locality 233, northwest corner of El Conejo Land Grant, Ventura Co.; length 30 mm.......... page 565

FIG. 22. *Spirotropis (Antiplanes) perversa* (Gabb), specimen No. 239 S. D. S. N. H., from the lower San Pedro of San Pedro; length 33 mm. This is a dextral specimen of a species which has a strong tendency to be sinistral.. page 553

FIGS. 23. *Spirotropis (Antiplanes) perversa* (Gabb), specimen No. 240 S. D. S. N. H., from the same locality as the specimen shown in fig. 22; length 29 mm. This is a sinistral specimen, a form more common in this species than the dextral. Fig. 23*a* is the same photograph as that shown in 23*b* reversed to show that the differences in the dextral and sinistral forms are all attributable to the accident of the way the shell began to coil............ page 553

FIG. 24. *Spirotropis (Antiplanes) perversa* (Gabb), ? variety *pedroana* (Arnold), specimen No. 241 S. D. S. N. H., from the same locality as the specimens shown in figs. 22 and 23; length 25 mm. This is a sinistral specimen badly weathered in such a way as to produce a channeled suture like that shown in fig. 32. The trace of the posterior notch is also eroded out, producing a spiral line.. page 556

FIG. 25. *Spirotropis (Antiplanes) perversa* (Gabb) variety *fernandoensis* (English), specimen No. 242 S. D. S. N. H., from locality 207, lower Pliocene of Elsmere Canyon; length 30 mm.... page 557

FIG. 26. *Spirotropis (Antiplanes)* cf. *bulimoides* (Dall), specimen No. 243 S. D. S. N. H., from locality 207, found with the specimen shown in fig. 25, length of incomplete specimen 30 mm.... page 557

FIG. 27. *Borsonia bartschi* (Arnold), specimen No. 637 in the collection at Stanford University, from the Pleistocene at San Pedro; length 25 mm. This specimen is an unusually elongate variation.. page 545

FIG. 28. *Borsonia bartschi* (Arnold), specimen No. 638 in the collection at Stanford University, found with the specimen shown in fig. 27, length 17 mm. This specimen is more typical in shape. The columellar plication is very faint, but is unquestionably present.......... page 545

FIG. 29. *Spirotropis (Typhlomangelia)* cf. *renaudi* (Arnold), specimen No. 244 S. D. S. N. H., from locality 218, Santa Barbara zone, upper Pliocene of Sulphur Canyon, east of South Mt., Ventura Co.; length 18 mm. This specimen, being badly weathered, appears to have lost most of the sculpture characteristic of this species............................ page 549

FIG. 30. *Moniliopsis graciosana* (Arnold) variety *mercedensis* (Martin), specimen No. 245 S. D. S. N. H., from locality 233, found with the specimen shown in fig. 21, lower Pleistocene; length 26 mm. The *Moniliopsis* form of the notch is well shown, but the sculpture of the spire is hidden by encrusting bryozoa.. page 569

FIG. 31. *Anachis (Chauvetia) lineolata* (Gray in Reeve), Recent specimen from San Hippolite Point, Lower California, labeled 356A in the collection at Stanford University; × 5, length 4.5 mm .... page 686

FIG. 32. *Spirotropis (Antiplanes) perversa* (Gabb) variety *pedroana* (Arnold), specimen No. 246 S. D. S. N. H., found with the specimens shown in figs. 22, 23, and 24; length 19 mm.......... page 556

FIG. 33. *Moniliopsis incisa* (Carpenter) variety *quinquecincta*, new variety, type, specimen No. 247 S. D. S. N. H., from locality 207, lower Pliocene of Elsmere Canyon, Los Angeles Co.; length 20 mm.. page 568

FIG. 34. *Anachis (Chauvetia) lineolata* (Gray in Reeve), Recent specimen, from the same lot as the specimen shown in fig. 31; × 5, length 4.5 mm.................................. page 686

FIG. 35. *Mitrella carinata* (Hinds), typical variety, specimen No. 248 S. D. S. N. H., from locality 78, low, upper Pleistocene terrace ½ mi. south of Seacliff Station on the S. P. R. R. about 8 mi. northwest of Ventura; × 2, length 6.5 mm. The carination, though strong, affects only the last three-quarters of the body whorl.................................... page 692

FIG. 36. *Hemipleurotoma archimedis* (Bellardi), type of the genus *Hemipleurotoma* Cossmann 1889, reproduction of Bellardi's original figure of the type specimen from the middle Miocene of Italy; length 38 mm.. page 570

FIG. 37. *Taranis strongi* (Arnold), specimen No. 639 in the collection at Stanford University, from the Pleistocene of San Pedro; × 2, length 12 mm.................................... page 572

(*Continued on page 941*)

EXPLANATION OF PLATE 26—(Continued)

FIG. 38. *Strombina recurva* (Sowerby), specimen No. 249 S. D. S. N. H., from old beach north of Turtle Cove, Albemarle Island, Galapagos Group; × 2, length 13 mm. This specimen is like the one shown in fig. 41, except that the body whorl is broken off, giving it a very slender appearance . . . . page 699

FIG. 39. *Amphissa columbiana* Dall, specimen No. 250 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; length 18.5 mm . . . . page 701

FIG. 40. *Nassarius* (*Tritia*) *mendicus* (Gould) variety *cooperi* (Forbes), specimen No. 251 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; length 19 mm . . . . page 674

FIG. 41. *Strombina recurva* (Sowerby), specimen No. 252, from old beach north of Turtle Cove, Albemarle Island, Galapagos Group; length 26 mm. This specimen is a good illustration of the genus *Strombina* . . . . page 699

FIG. 42. *Pyrene discors* (Gmelin), Recent specimen from the Philippine Islands, No. 640 in the collection at Stanford University; length 17 mm . . . . page 680

FIG. 43. *Nassarius* (*Nassarius*) *tegula* (Reeve), Recent specimen from San Diego labeled 837A in the collection at Stanford University, natural size . . . . page 671

FIG. 44. *Mitrella carinata* (Hinds) variety *gausapata* (Gould), specimen No. 253 S. D. S. N. H., found with the specimen shown in fig. 35, upper Pleistocene; × 2, length 8 mm. This is really but a variant of *carinata*, *s. s* . . . . page 693

FIG. 45. *Mitrella tuberosa* (Carpenter), specimen No. 254 S. D. S. N. H., from locality 218, upper Pliocene of Sulphur Canyon, east of South Mt., Ventura Co.; length 7 mm. This specimen is not particularly characteristic of the species, the spire being lower than usual and the body whorl less angulated at the base. It illustrates the variation of the species. A more typical specimen was found with it . . . . page 697

FIG. 46. *Mitrella grandior*, new species, type, specimen No. 6 S. D. S. N. H., from locality 221, middle Pliocene of Cañada de Aliso, Ventura Co.; length 22 mm. It is interesting to note that a very similar species, if indeed this is not the same, occurs in practically the same horizon in the English Pliocene . . . . page 696

FIG 47. *Anachis* (*Anachis*) *gaskoini* Carpenter, Recent specimen from Point Abreojos, Lower California, labeled No. 887A in the collection at Stanford University; × 5, length 6 mm . . . . page 685

FIGS. 48. *Nassarius* (*Uzita*) *arnoldi* (Anderson) variety *whitneyi* (Trask), specimen No. 7 S. D. S. N. H., from the middle Etchegoin at a depth of 2680 feet in the Federal Exploration Company's well Kinsella No. 1 near Tipton, Tulare Co.; × 2, length 15 mm. This specimen was somewhat flattened by the consolidation of the bed in which it occurred . . . . page 679

FIG. 49. *Nassarius* (*Tritia*) *californianus* (Conrad), specimen No. 255 S. D. S. N. H., from locality 204, lower Pliocene of Elsmere Canyon, Los Angeles Co.; length (incomplete) 17 mm. This species does not have the varix on the outer lip. It is the type of Conrad's *Schizopyga* . . page 672

FIG. 50. *Nassarius* (*Tritia*) *mendicus* (Gould) variety *cooperi* (Forbes), specimen No. 256 S. D. S. N. H., from the same locality as the specimen shown in fig. 40; length 17 mm. It will be noticed that this specimen is a relatively shorter variant . . . . page 674

FIG. 51. *Nassarius* (*Tritia*) *perpinguis* (Hinds), tall form, specimen No. 257 S. D. S. N. H., from the same locality as the specimens shown in figs. 40 and 50; length 17 mm . . . . page 673

FIG. 52. *Nassarius* (*Tritia*) *perpinguis* (Hinds), tall form, specimen No. 258 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, north of the Santa Clara Valley, Los Angeles Co.; length 17.5 mm . . . . page 673

FIG. 53. *Amphissa versicolor* Dall, specimen No. 259 S. D. S. N. H., from the lower Pleistocene of Stanford University locality 602, west bank of road-cut 1500 feet north of crossing of Rincon Creek by California State Highway, southeastern corner of Santa Barbara Co.; × 2, length 12 mm . . . . page 702

FIG. 54. *Nassarius* (*Tritia*) *mendicus* (Gould), typical variety, short form, specimen No. 260 S. D. S. N. H., from locality 74, same locality as that at which the specimens shown in figs. 40, 50, and 51 were found; × 2, length 10 mm. This specimen is immature . . . . page 674

FIG. 55. *Nassarius* (*Tritia*) *fossatus* (Gould), young specimen, No. 261 S. D. S. N. H., from locality 74, low, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; length 16 mm . . . page 675

FIG. 56. *Nassarius* (*Tritia*) *fossatus* (Gould), adult specimen, No. 262 S. D. S. N. H., from the same locality as the specimen shown in fig. 55; length 34 mm . . . . page 675

EXPLANATION OF PLATE 27

Fig. 1. *Cancellaria tritonidea* Gabb variety *fernandoensis* Arnold, specimen No. 263 S. D. S. N. H., from locality 216, basal Pliocene east of Fernando Pass, Los Angeles Co.; length 28 mm. English figures a similar form from the same horizon in Elsmere Canyon. Arnold's type lacked the mature whorl .... page 618

Fig. 2. *Cancellaria calvatula* Sowerby, specimen No. 264 S. D. S. N. H., from locality 216, found with the specimen shown in fig. 1; length 21 mm. This specimen may represent the form described by English as *elsmerensis*, but the latter has a somewhat different shape ..... page 615

Fig. 3. *Cancellaria hemphilli* Dall, specimen No. 265 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, Los Angeles Co.; length 23 mm. This specimen is like the type except that it has fewer axial ridges (eight to a whorl) .... page 621

Fig. 4. *Cancellaria obesa* Sowerby, variety *planospira*, new variety, type, No. 266 S. D. S. N. H., from locality 216, lower Pliocene east of Fernando Pass, Los Angeles Co. This specimen does not appear to be the young of any of the other species described from nearby localities .... page 613

Fig. 5. *Admete modesta* (Carpenter), variety with less tabulate whorls, possibly variety *gracilior* Carpenter in Gabb (not Arnold), specimen No. 267 S. D. S. N. H., from locality 218, upper Pliocene, Santa Barbara zone, in Sulphur Canyon east of South Mt., Ventura Co.; × 2, length 10 mm .... page 622

Fig. 6. *Psephæa prevostiana* (Crosse) variety *oregonensis* (Dall), specimen No. 641 in the collection at Stanford University, from the Pliocene of Fuglers Point, Santa Barbara County, California; length 51 mm. This is an immature specimen with unusually few axial ribs .... page 634

Fig. 7. *Cancellaria tritonidea* Gabb variety *altispira* Gabb, type specimen of *Cancellaria newhallensis* Carson, No. 108 in the collection at Stanford University, from the lower Pliocene of Elsmere Canyon, Los Angeles Co.; length 66 mm .... page 618

Fig. 8. *Cancellaria tritonidea* Gabb, typical variety, type specimen of *Cancellaria perrini* Carson, No. 102 in the collection at Stanford University, from the same locality as the specimen shown in fig. 6; length 61 mm .... page 616

Fig. 9. *Psephæa prevostiana* (Crosse), typical variety, Recent specimen from Japan, labeled A in the collection at Stanford University; length 143 mm .... page 633

Fig. 10. *Psephæa prevostiana* (Crosse) variety *oregonensis* (Dall), specimen No. 642 in the collection at Stanford University (U. S. N. M. No. 110429), from the lower Purisima beds at Año Nuevo Point, middle California; length (incomplete) 82 mm. It is easy to see that this form, previously known as *Miopleiona oregonensis*, is but a doubtfully valid variety of the living Japanese species .... page 634

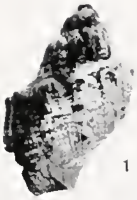
Fig. 11. *Fusinus barbarensis* (Trask), specimen No. 268 S. D. S. N. H., from locality 263, middle Pliocene between Pico Canyon and Fernando Pass, Los Angeles Co.; length of incomplete specimen 81 mm. The long, narrow anterior canal of this specimen is broken off. If 6 mm. were restored to the spire and 23 mm. to the canal, the length would be 110 mm... page 639

Fig. 12. *Ranella (Priene) oregonensis* (Redfield), specimen No. 269 S. D. S. N. H., from locality 218, upper Pliocene, Santa Barbara zone, in Sulphur Canyon east of South Mt., Ventura Co.; length of incomplete specimen 38 mm .... page 737

Fig. 13. *Cypræa spadicea* Swainson, specimen No. 270 S. D. S. N. H., from locality 217*a*, middle Pliocene of Holser Canyon, Los Angeles Co.; length 34 mm .... page 752

Figs. 14. *Forreria magister* (Nomland), specimen No. 271 S. D. S. N. H., from locality 203, lower Pliocene of Elsmere Canyon, Los Angeles Co.; length of incomplete specimen 82 mm .... page 727

Figs. 15. *Cancellaria hemphilli* Dall, specimen No. 272 S. D. S. N. H., from locality 263, middle Pliocene, between Pico Canyon and Fernando Pass, Los Angeles Co.; length 38.5 mm. This specimen is not worn so badly as the one shown in fig. 3. The channeled suture is quite plain .... page 621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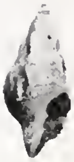
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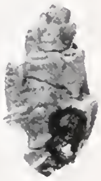
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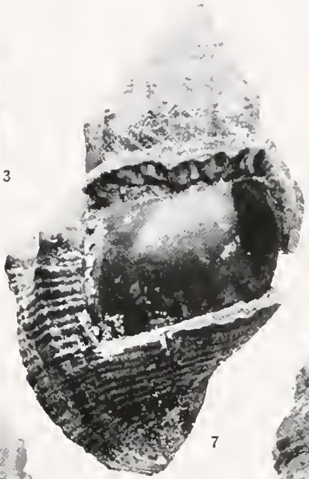
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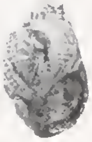
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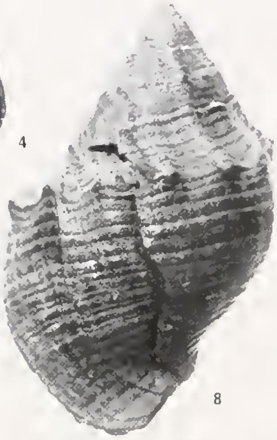
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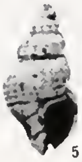
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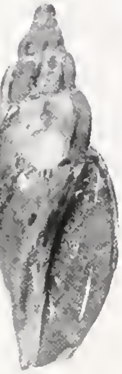
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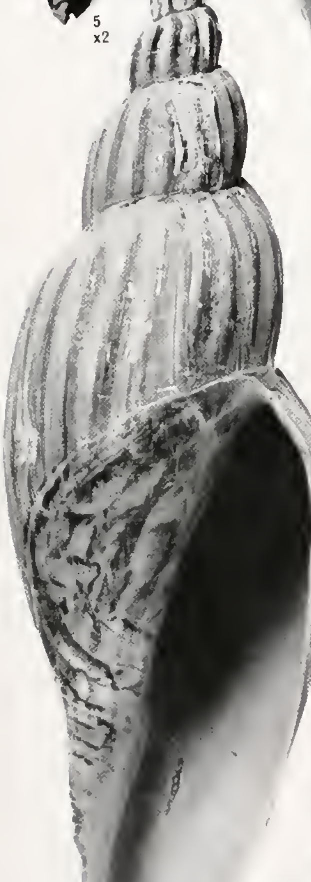
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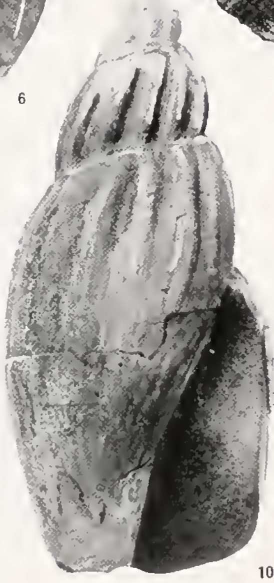
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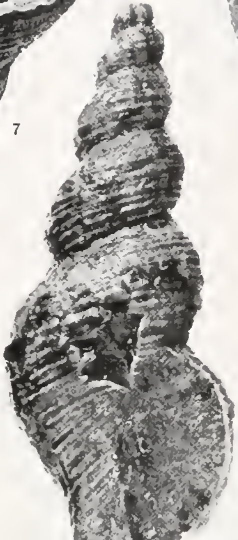
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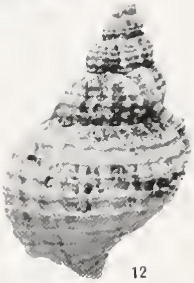
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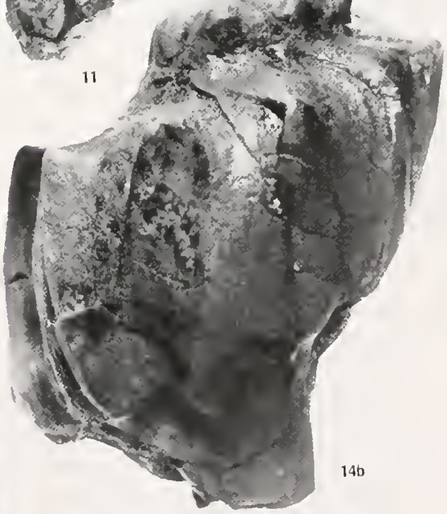
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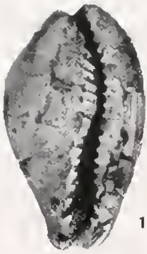
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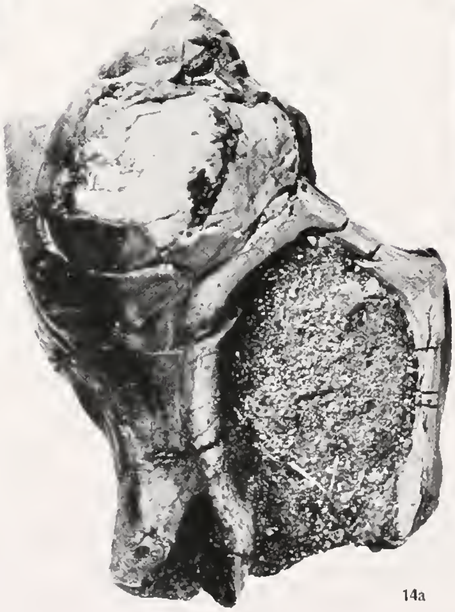
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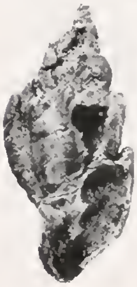
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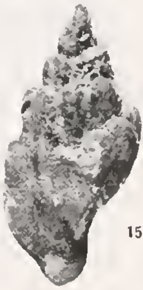
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EXPLANATION OF PLATE 28

FIGS. 1. *Neptunea (Neptunea) antiqua* (Linnæus), variety *despecta* (Linnæus), reproduction of Kiener's illustrations of "*Fusus despectus* Lamarck," Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Fuseau*, p. 29, pl. 19, figs. 2, 1840; length 4 pouces, 2 lines (according to Kiener) = about 105 mm., hence Kiener's reduction was to about ⅔ natural size. . . . . page 653

FIG. 2. *Cantharus fortis* (Carpenter), typical variety, specimen No. 273 S. D. S. N. H., from Stanford University locality 274, Las Posas zone, lower Pleistocene on east side of Santa Paula Creek, Ventura Co.; length (spire incomplete) 44 mm. . . . . page 647

FIG. 3. *Cantharus humerosus* (Gabb), specimen No. 274 S. D. S. N. H., from locality 263, middle Pliocene between Pico Canyon and Fernando Pass, Los Angeles Co.; length 53 mm. This species is common and rather variable in the middle Pliocene of southern California. . . . page 647

FIG. 4. *Mitra catalinæ* (Dall), specimen No. 275 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, north of the Santa Clara Valley, Los Angeles Co.; length 23 mm. . . . page 636

FIG. 5. *Exilioidea rectirostris* (Carpenter), specimen No. 643 in the collection at Stanford University, from the Pleistocene of San Pedro; length 31 mm. . . . . page 665

FIG. 6. *Kelletia (Searlesia) dira* (Reeve), Recent specimen from Cape Gregory, Oregon, labeled A in the collection at Stanford University; length 37 mm. It is probable that this subgenus should be submerged in *Kelletia, s. s.* This species is smaller than *Kelletia kelletii* and the spiral sculpture is not so markedly differentiated . . . . page 645

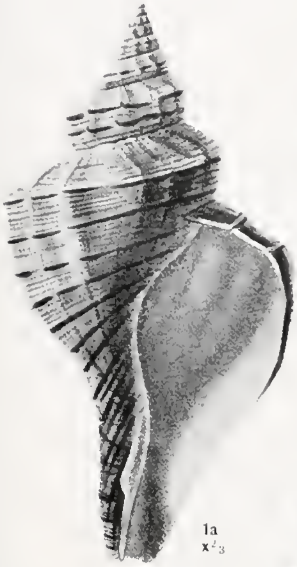
FIG. 7. *Kelletia (Kelletia) kelletii* (Forbes), specimen No. 276 S. D. S. N. H., from locality 203, lower Pliocene of Elsmere Canyon, Los Angeles Co.; length 92 mm . . . . page 642

FIG. 8. *Macron æthiops* (Reeve) variety *kellettii* (A. Adams), Recent specimen from Scammon's Lagoon, Lower California, labeled 1193A in the collection at Stanford University; length 56 mm. The variety occurs with the typical form and is probably not significant. . . . . page 650

FIGS. 9. *Neptunea (Neptunea) andersoni* (Martin) variety *hawleyi* (Carson), specimen No. 317 S. D. S. N. H., from locality 218, upper Pliocene of Sulphur Canyon east of South Mt., Ventura Co. This large specimen was badly broken. Fig. 9*a* represents a fragment of the spire; fig. 9*b* is a side view of the body whorl showing the sculpture, length of this portion about 83 mm.; fig. 9*c* shows the aperture, outer lip complete; length of the whole if restored about 125 mm . . . . page 655

FIG. 10. *Neptunea (Neptunea) antiqua* (Linnæus), typical variety, reproduction of one of Kiener's illustrations of "*Fusus antiquus* Lamarck," Spéc. Gén. et Icon. Coq. Viv., Vol. 5, *Fuseau*, p. 28, plate 18, fig. 1*b*, 1840; length 5 pouces, 9 lines (according to Kiener) = about 145 mm., hence Kiener's reduction was to about ⅔ natural size. Habitat with the variety *despecta*, northern seas. . . . . page 653

FIG. 11. *Neptunea (Colus) jordani* (Dall), specimen No. 277 S. D. S. N. H., from Stanford University locality N. P. 27, upper Pliocene (or lower Pleistocene ?) near the mouth of the Elk River, Oregon; length 38 mm. . . . . page 663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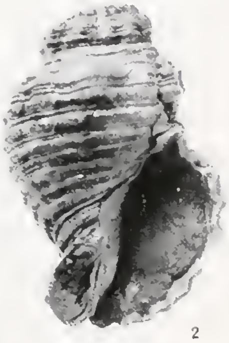
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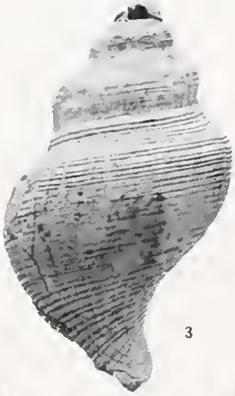
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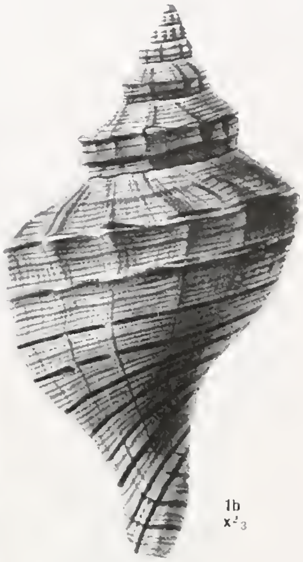
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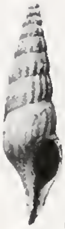
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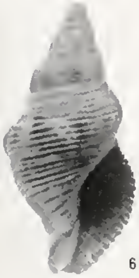
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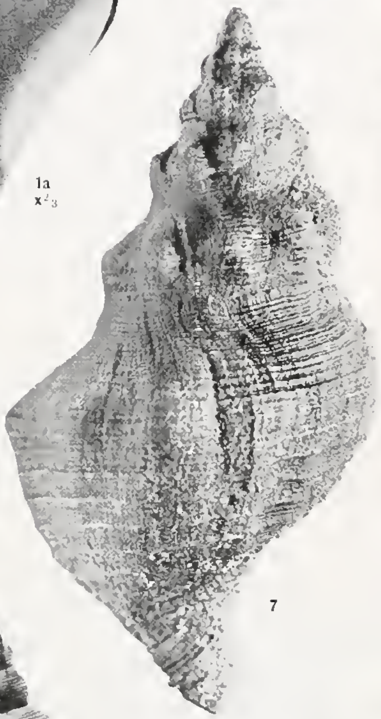
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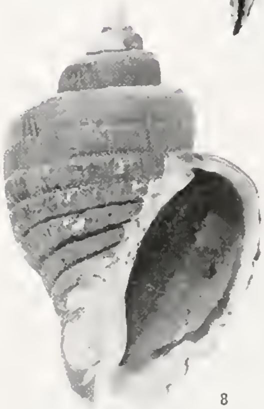
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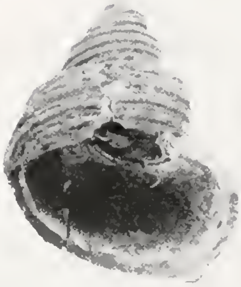
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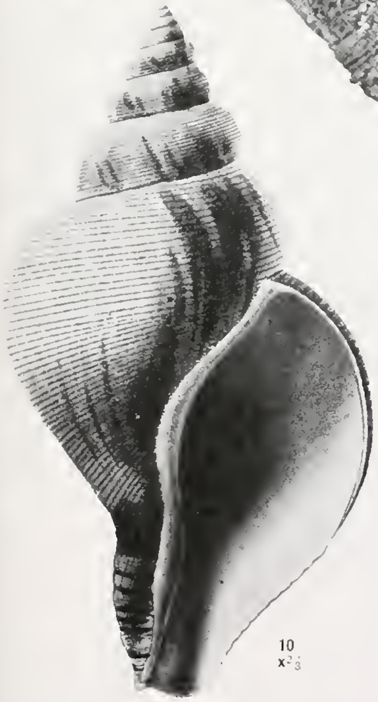
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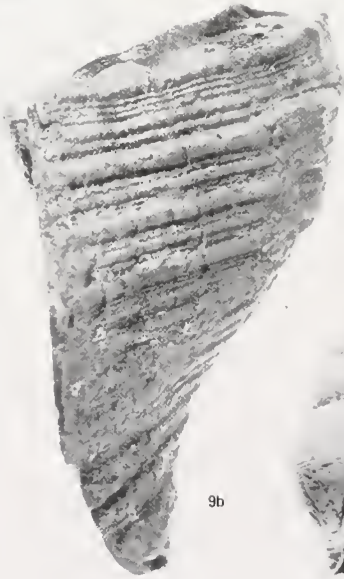
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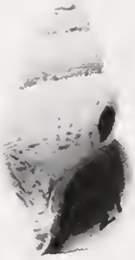
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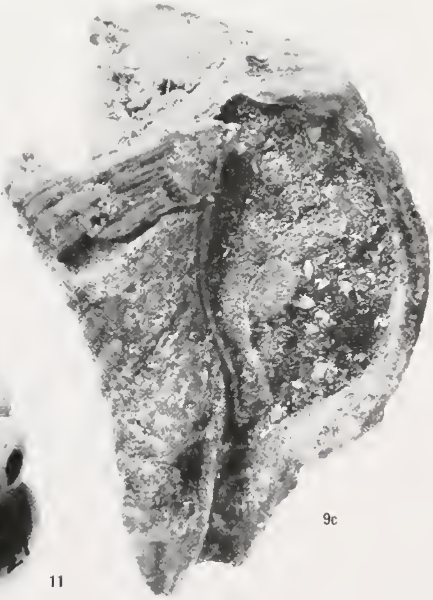
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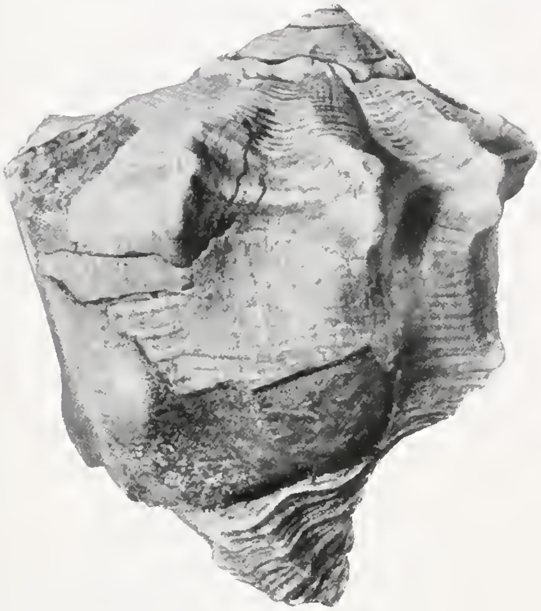
EXPLANATION OF PLATE 29

Figs. 1. *Ficus* (*Trophosycon*) *ocoyana* (Conrad) variety *contignata*, new variety, type, specimen No. 4 S. D. S. N. H., from locality 203, lower Pliocene of Elsmere Canyon; length 92 mm. The top of this specimen is shown in fig. 2 of the next plate.............................. page 749

Figs. 2. *Ficus* (*Trophosycon*) *ocoyana* (Conrad) variety *ruginodosa*, new variety, type, specimen No. 3 S. D. S. N. H., from locality 209, lower Pliocene of Elsmere Canyon; length 110 mm. Younger specimens are shown on the next plate.............................. page 746



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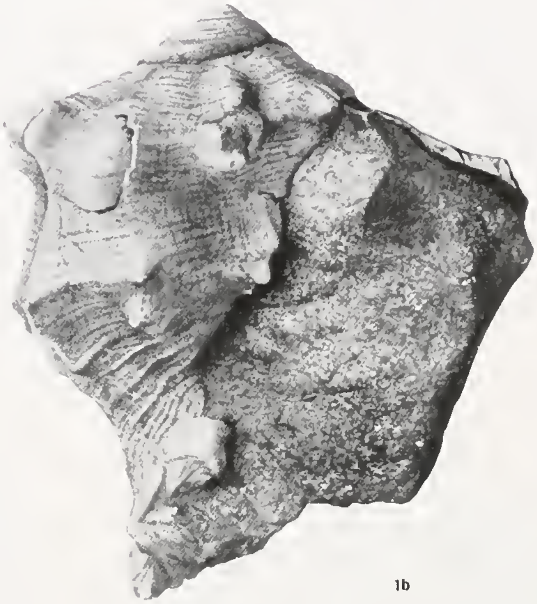

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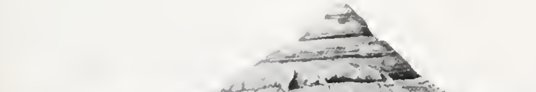

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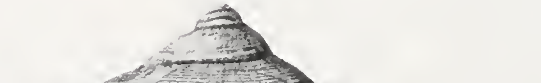

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EXPLANATION OF PLATE 30

Fig. 1. *Ficus (Trophosycon) ocoyana* (Conrad) variety *contiguata*, new variety, paratype, specimen No. 644 in the collection at Stanford University, from the Jacalitos formation, middle California, lower Pliocene; natural size . . . . page 749

Fig. 2. *Ficus (Trophosycon) ocoyana* (Conrad) variety *contiguata*, new variety, type, top view of specimen shown on plate 29, figs. 1; greatest dimension shown 83 mm . . . . page 749

Fig. 3. *Ficus (Trophosycon) ocoyana* (Conrad), typical variety, specimen No. 645 in the collection at Stanford University labeled Griswold's (between San Juan and New Idria, Monterey Co.), Miocene, natural size. This cast has the shape illustrated in the original drawing of *ocoyana* . . . . page 743

Fig. 4. *Ficus (Trophosycon) ocoyana* (Conrad) variety *contiguata*, new variety, stunted form, paratype, specimen No. 278 S. D. S. N. H., from locality 227, lower Pliocene south of Humphreys Station, upper part of the Santa Clara Valley, Los Angeles Co.; length (incomplete) 20 mm . . . . page 749

Fig. 5. *Ficus (Trophosycon) ocoyana* (Conrad) variety *ruginodosa*, new variety, young, specimen No. 646 in the collection at Stanford University, from the lower Pliocene of Elsmere Canyon, Los Angeles Co.; length 40 mm. The nodes begin on the rear of the body whorl of this specimen . . . . page 746

Figs. 6. *Ficus (Trophosycon) clallamensis* Weaver variety *nodibulbosa*, new variety, type, specimen No. 2977 in the collection of the California Academy of Sciences, from the Santa Margarita formation, upper Miocene of middle California; length 85 mm. The sculpture is not well brought out in the illustration . . . . page 751

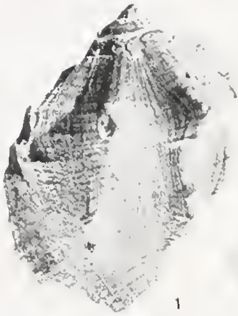
Fig. 7. *Ficus (Trophosycon) ocoyana* (Conrad), cf. *clallamensis* Weaver, specimen No. 647 in the collection at Stanford University, from the Temblor horizon, middle Miocene "on ridge south of house on Rabbit Canyon Road, Branch of Santiago Canyon, Orange Co. Calif.," collected by C. A. Waring; partial length 43 mm . . . . pages 743, 750

Figs. 8. *Ficus (Trophosycon) ocoyana* (Conrad), typical variety, topotype, specimen No. 648 in the collection at Stanford University, from the Temblor formation, middle Miocene of Barker's Ranch, Poso Creek, Kern Co.; natural size . . . . page 743

Figs. 9. *Ficus (Trophosycon) ocoyana* (Conrad) variety *contiguata*, new variety, specimen No. 279 S. D. S. N. H., from the lower Pliocene of Elsmere Canyon, Los Angeles Co.; natural size . . page 749

Figs. 10. *Ficus (Trophosycon) ocoyana* (Conrad) variety *ruginodosa*, new variety, young, specimen No. 280 S. D. S. N. H., from the lower Pliocene of Elsmere Canyon, Los Angeles Co., natural size. This form is easily mistaken for a typical *Ficus* . . . . page 746

Fig. 11. *Ficus (Trophosycon) ocoyana* (Conrad), typical variety, specimen No. 281 S. D. S. N. H., from the middle Miocene of locality 41, type locality of *Agasoma stanfordensis* Arnold, southwest of Mayfield, Santa Clara Co.; natural size. This poor cast adds little information to what was formerly known of the form *stanfordensis*, except to show that the nodes are of much the same shape as those of typical *ocoyana*, at least as far as casts are concerned, and authentic specimens of *stanfordensis* are not known that retain any of the shell . . . . page 743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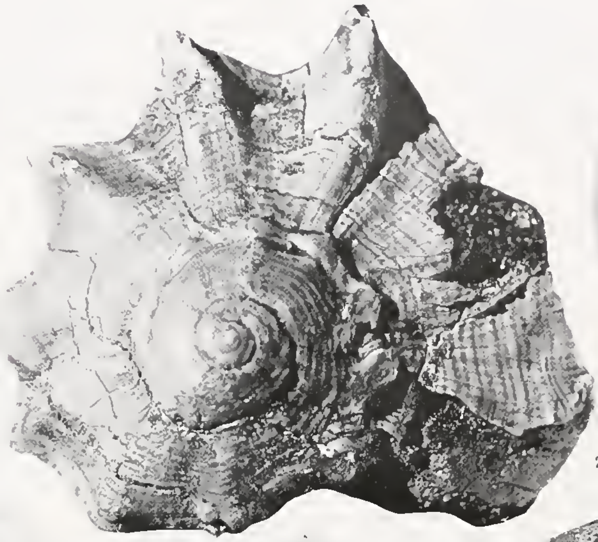
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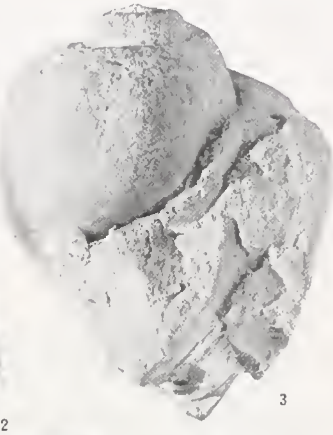
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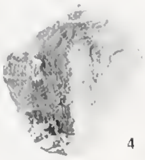
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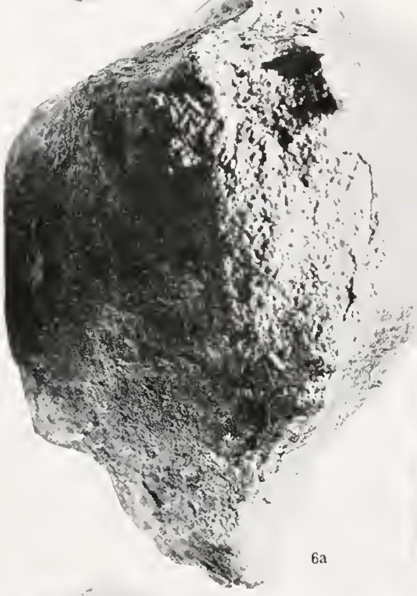
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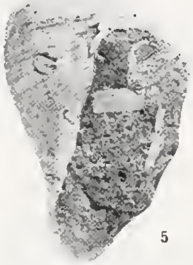
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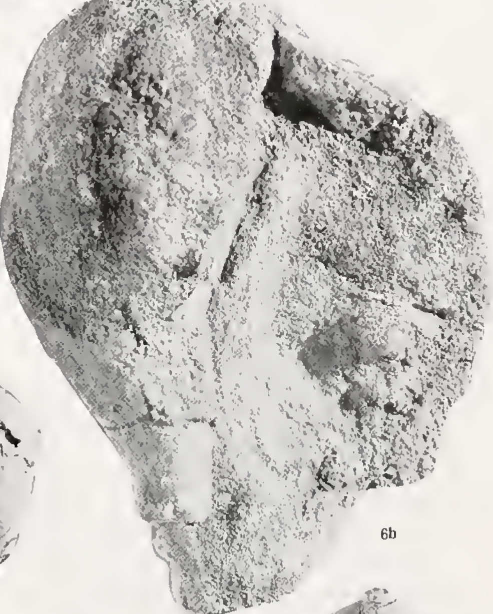
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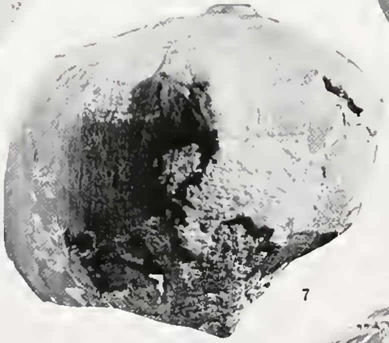
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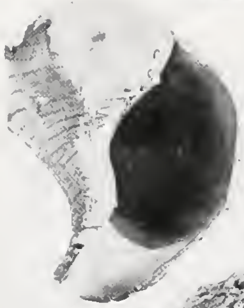
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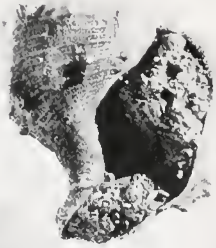
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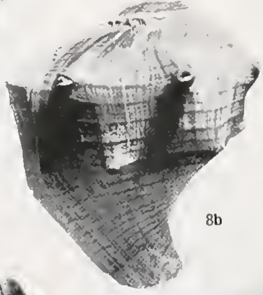
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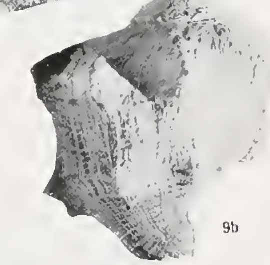
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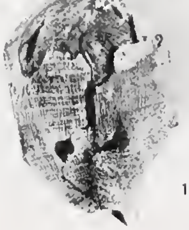
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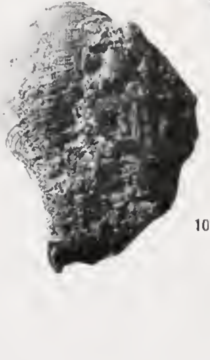
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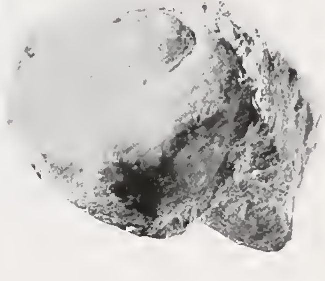
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EXPLANATION OF PLATE 31

FIGS. 1. *Astræa* (*Pomaulax*) *gradata*, new species, paratype, specimen No. 282 S. D. S. N. H., from locality 217*b*, middle Pliocene of Holser Canyon, north of the Santa Clara Valley, Los Angeles Co.; altitude 17 mm. . . . . page 818

FIG. 2. *Astræa* (*Pomaulax*) *turbanica* (Dall), type, specimen No. 111242 in the U. S. National Museum, from U. S. Fish Commission station 2989 in 36 fathoms, coral, off Magdalena Bay, Lower California; natural size. The operculum of this species is said to be like that shown in fig. 9 . . . . page 819

FIGS. 3. *Astræa* (*Pomaulax*) *gradata*, new species, paratype, specimen No. 283 S. D. S. N. H., from locality 214, middle Pliocene west of Fernando Pass, Los Angeles Co.; partial altitude 43 mm., in position shown would measure 38 mm . . . . page 818

FIGS. 4. *Astræa* (*Pachypoma*) *inæqualis* (Martyn), specimen No. 284 S. D. S. N. H., from locality 101, from hard sandstone stratum in tilted beds about 100 yards west of pier at Bath-House Beach, Santa Barbara, upper Pliocene; altitude 36 mm., in position shown 31 mm. The operculum of this species is shown in fig. 10 . . . . page 820

FIG. 5. *Astræa* (*Pomautax*) *gradata*, new species, paratype, specimen No. 285 S. D. S. N. H., from locality 217*b*, the locality at which the specimen shown in figs. 1 was found, basal view, natural size This specimen was unfortunately rather badly broken in packing after it was photographed . . . . page 818

FIGS. 6. *Astræa* (*Pomautax*) *undosa* (Wood), Recent specimen from San Diego, labeled 1231 in the collection at Stanford University; altitude from the base of the umbilical callus to the tip of the spire 60 mm. (the outer lip somewhat lower than the base of the umbilical callus) . . . . page 818

FIG. 7 *Astræa* (*Pomaulax*) *undosa* (Wood), Recent specimen from San Pedro, labeled 618A in the collection at Stanford University. Exterior of operculum, length 42 mm . . . . page 818

FIG. 8. *Astræa* (*Pomaulax*) *gradata*, new species, type, specimen No. 286 S. D. S. N. H., from locality 228, middle Pliocene between Pico Canyon and Fernando Pass, Los Angeles Co.; altitude 75 mm. This specimen is higher spired than the others, but they all belong unquestionably to the same species . . . . page 818

FIG. 9. *Astræa* (*Pomaulax*) *gradata*, new species, paratype, specimen No. 287 S. D. S. N. H., from locality 217*b*, found with the specimens shown in figs. 1 and 5. Exterior of operculum, length 27 mm. The other side of this specimen is smooth except for lines marking its spiral growth . . . . page 818

FIG. 10. *Astræa* (*Pachypoma*) *inæqualis* (Martyn), specimen No. 649 in the collection at Stanford University, from the lower San Pedro Pleistocene at San Pedro. Exterior of operculum, length 21 mm . . . . page 820

FIG. 11. *Calyptræa* (*Trochita*) *trochiformis* (Gmelin), Recent specimen from Callao, Peru, labeled 342–2A in the collection at Stanford University; diameter 63 mm. In the Tertiary of California this species has been known as *C. costellata* and in the Recent it has been better known as *C. radians* . . . . page 795

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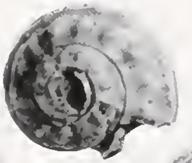
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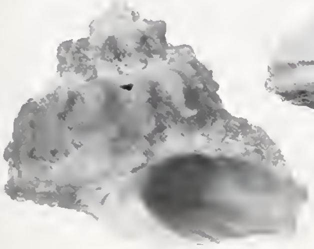
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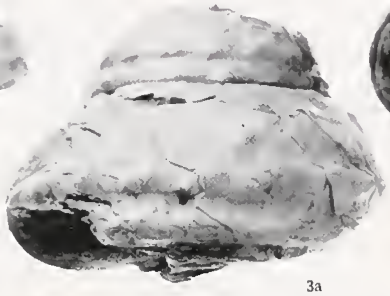
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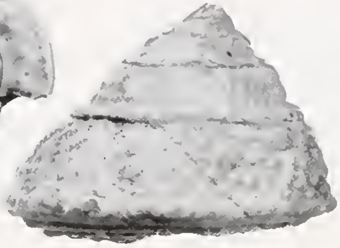
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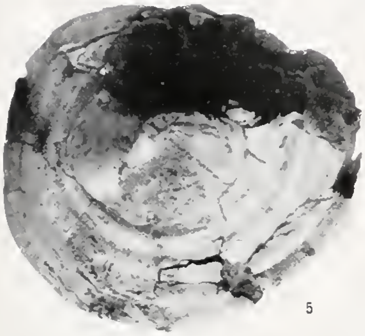
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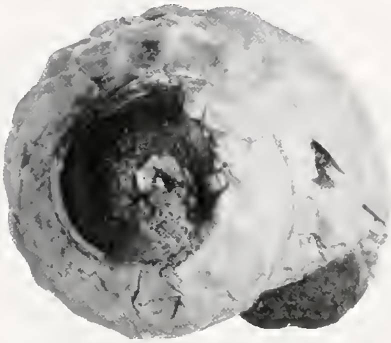
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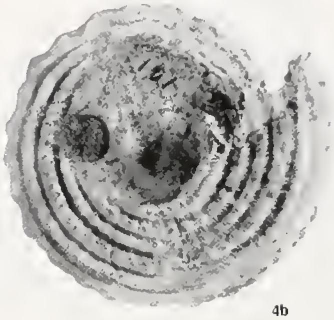
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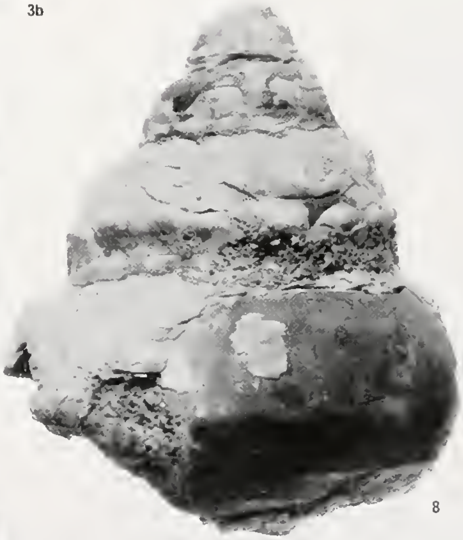
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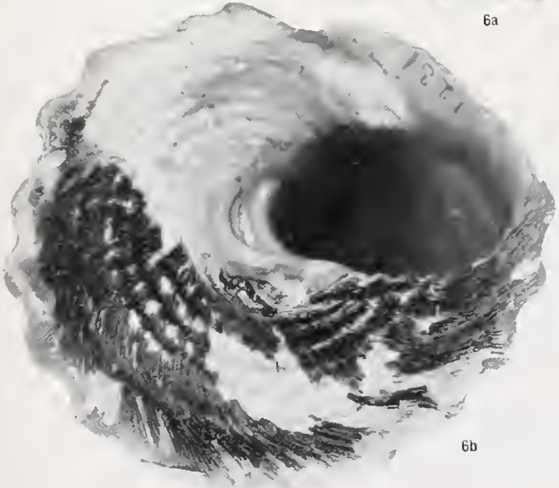
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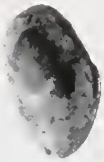
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EXPLANATION OF PLATE 32

Fig. 1. *Purpura* (*Jaton*) *eldridgei* (Arnold), specimen No. 288 S. D. S. N. H., from locality 216, lower Pliocene east of Fernando Pass, Los Angeles Co.; natural size. This species is very similar to *P. gemma* of the Recent fauna . . . . page 708

Figs. 2. *Purpura* (*Jaton*) *eldridgei* (Arnold), specimen No. 289 S. D. S. N. H., from the same locality as the specimen shown in fig. 1; length 31 mm . . . . page 708

Fig. 3. *Purpura* (*Jaton*) *festiva* (Hinds), specimen No. 290 S. D. S. N. H., from the Pleistocene of San Pedro; length 38 mm . . . . page 708

Fig. 4. *Tritonalia lurida* (Middendorff) variety *aspera* (Baird), specimen No. 291 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; length 29 mm . . . . page 711

Fig. 5. *Tritonalia lurida* (Middendorff) variety *munda* (Carpenter), specimen No. 292 S. D. S. N. H., from locality 74, found with the specimen shown in fig. 4; × 2, length 11 mm . . . . page 712

Fig. 6. *Acanthina spirata* (Blainville), angulate variety, specimen No. 293 S. D. S. N. H., from the San Pedro Pleistocene; length 36 mm . . . . page 720

Fig. 7. *Acanthina spirata* (Blainville), angulate variety, specimen No. 294 S. D. S. N. H., from locality 244, Las Posas zone, lower Pleistocene in Sexton Canyon, Ventura Co.; length 28 mm . . . page 720

Fig. 8. *Acanthina spirata* (Blainville), round-shouldered variety, Recent specimen from Bolinas Bay, middle California, labeled 709A in the collection at Stanford University; length 32 mm . page 720

Fig. 9. *Trophon* (*Boreotrophon*) *orpheus* (Gould), specimen No. 295 S. D. S. N. H., from locality 218, Santa Barbara zone of Sulphur Canyon east of South Mt., Ventura Co.; length 25 mm . . . page 722

Fig. 10. *Tritonalia poulsoni* (Nuttall in Carpenter), young specimen, No. 296 S. D. S. N. H., from the San Pedro Pleistocene; length 25 mm . . . . page 712

Fig. 11. *Tritonalia foveolata* (Hinds), specimen No. 297 S. D. S. N. H., from locality 243, Las Posas zone, lower Pleistocene in Adams Canyon, Ventura Co.; length 32 mm . . . . page 709

Fig. 12. *Chicoreus* (*Murithais*) *wilkesanus* (Anderson), specimen No. 298 S. D. S. N. H., from the upper (possibly middle) Miocene of the Superior Oil Company's well Ansolabehere No. 1, northwest of Bakersfield; length 55 mm . . . . page 730

Fig. 13. *Thais* (*Nucella*) *elsmerensis*, new species, type, specimen No. 299 S. D. S. N. H., from locality 216, lower Pliocene east of Fernando Pass, Los Angeles Co.; length 32 mm . . . . page 719

Fig. 14. *Thais* (*Nucella*) *lamellosa* (Gmelin), Recent specimen from Coos Bay, Oregon, labeled 738–12A in the collection at Stanford University; length 43 mm. This specimen is one of the numerous variations of this extremely variable species. Compare fig. 26 . . . . page 716

Fig. 15. *Thais* (*Nucella*) *lima* (Martyn), reproduction of Martyn's original figure; × 1, length of Martyn's figure 51 mm . . . . page 717

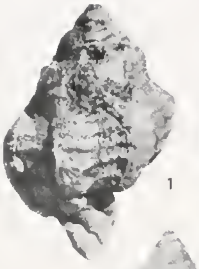
Fig. 16. *Littorina scutulata* Gould, specimen No. 300 S. D. S. N. H., from the Palos Verdes terrace of San Pedro, upper Pleistocene; × 2, length 10 mm. This figure and figs. 17 and 18 are given to show the variability within this species. These specimens are all from the same locality . . . . page 782

Fig. 17. *Littorina scutulata* Gould, specimen No. 301 S. D. S. N. H., found with the specimen shown in fig. 16 × 2, length 9 mm . . . . page 782

Fig. 18. *Littorina scutulata* Gould, specimen No. 302 S. D. S. N. H., found with the specimens shown in figs. 16 and 17; × 2, length 10 mm . . . . page 782

Fig. 19. *Lacuna divaricata* (Fabricius) variety *solidula* Lovén, specimen No. 303 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; × 2, length 8 mm. This species is extremely variable, perhaps the only species of *Lacuna* on the Pacific coast of North America. The genus is distinguished from *Littorina* by the umbilical trough behind the inner lip . . . . page 782

(*Continued on page 954*)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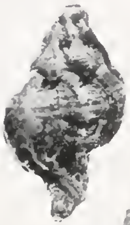
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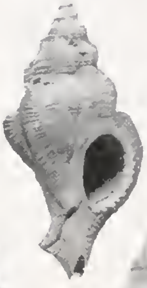
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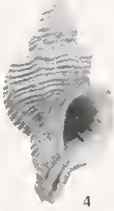
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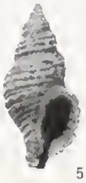
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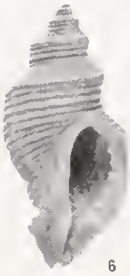
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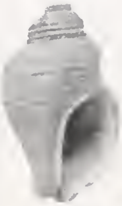
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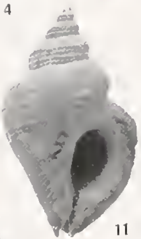
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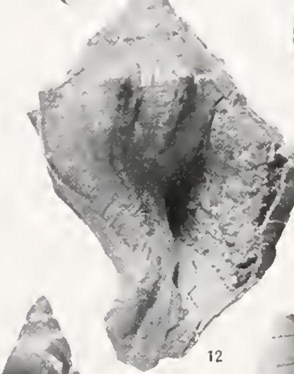
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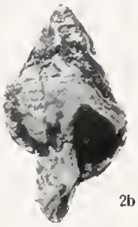
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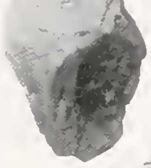
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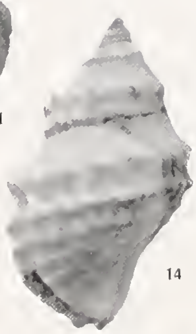
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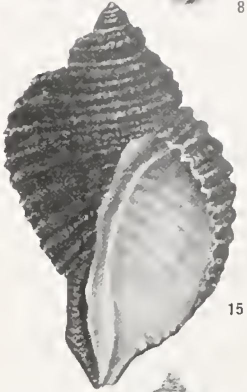
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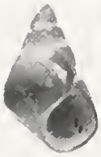
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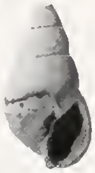
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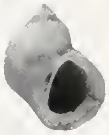
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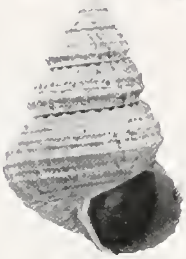
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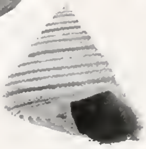
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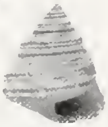
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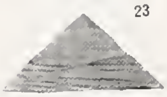
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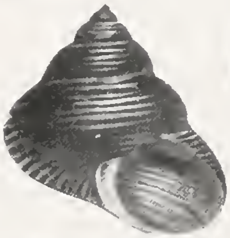
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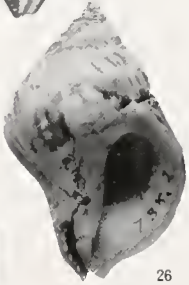
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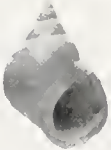
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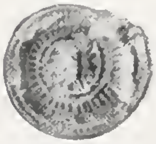
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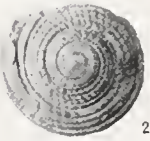
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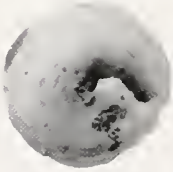
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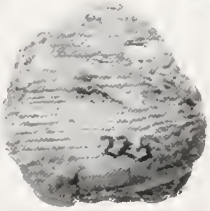
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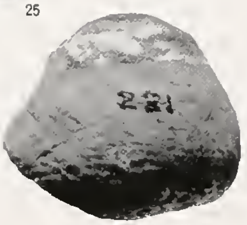
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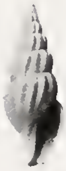
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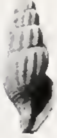
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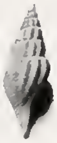
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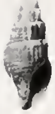
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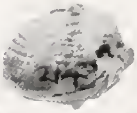
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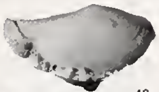
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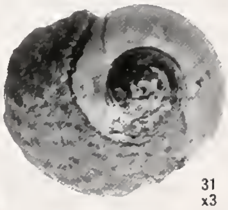
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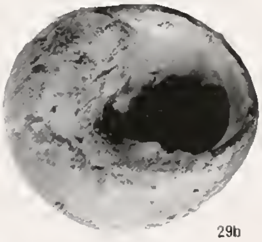
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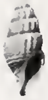
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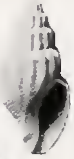
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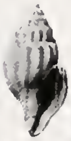
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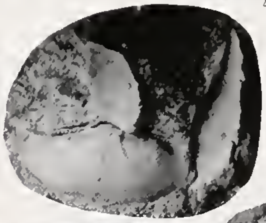
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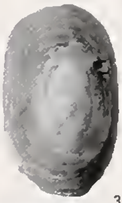
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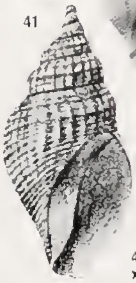
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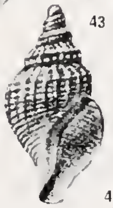
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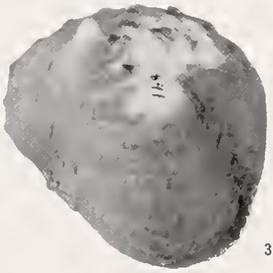
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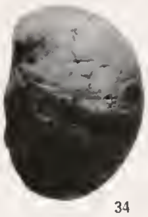
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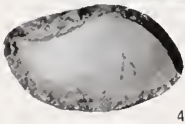
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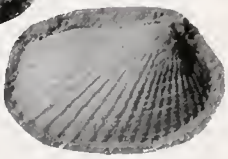
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EXPLANATION OF PLATE 32—(Continued)

FIG. 20. *Odostomia* cf. (*Amaura*) *avellana* Carpenter, specimen No. 304 S. D. S. N. H., from locality 74, found with the specimen shown in fig. 19; × 3, length 7.4 mm. The injury that this individual suffered may account for the umbilical chink. Compare the smaller specimen found with it shown on plate 24, fig. 25. The subgeneric and specific lines in this genus have been drawn without consideration of biologic entities. Positive identifications are often very difficult and usually mean very little .... page 876

FIG. 21. *Calliostoma gemmulatum* Carpenter, specimen No. 305 S. D. S. N. H., from locality 78, upper Pleistocene terrace one-half mile south of Seacliff Station, about 8 mi. northwest of Ventura; length 16 mm. This form is closely related to *C. costatum* (Martyn)......... page 835

FIG. 22. *Cidarina cidaris* (A. Adams), Recent specimen from Lopez Island, Puget Sound, labeled 510–3A in the collection at Stanford University; length 37 mm. The horny Trochid operculum is visible within the aperture.. page 838

FIG. 23. *Calliostoma canaliculatum* (Martyn), specimen No. 306 S. D. S. N. H., from the San Pedro Pleistocene; length 19.5 mm. This species is distinguished from *C. costatum* by its flattened base.. page 833

FIGS. 24. *Calyptræa mamillaris* Broderip, specimen No. 307 S. D. S. N. H., from locality 74, upper Pleistocene terrace southwest of Goleta, Santa Barbara Co.; altitude 10 mm., diameter 22.5 mm. Fig. 24*b* shows the deck in the interior that is characteristic of *Calyptræa*.... page 794

FIG. 25. *Calliostoma costatum* (Martyn), reproduction of Martyn's original figure, × 1, length of Martyn's figure 31.5 mm .... page 833

FIG. 26. *Thais* (*Nucella*) *lamellosa* (Gmelin), Recent specimen from Oakland, San Francisco Bay, California; length 46 mm. This specimen is one of the numerous variations of this species. Another is shown in fig. 14... page 716

FIG. 27. *Architectonica nobilis* Bolten variety *discus*, new variety, type, specimen No. 308 S. D. S. N. H., from about one mile southwest of Yuha drill hole, Imperial County, California, Pliocene ?; diameter 20.5 mm .... page 786

FIGS. 28. *Tegula* (*Chlorostoma*) *funebralis* (A. Adams), specimen No. 309 S. D. S. N. H., from locality 225, between Santa Paula Creek and Timber Canyon, Ventura Co., lower part of the upper Pliocene; altitude 27 mm. This specimen has much coarser spiral sculpture than the specimen shown in fig. 29. The distinctions between *funebralis* and *gallina* (figs. 30, 31) are chiefly in color and are of very doubtful value. The two forms vary through the same series of shapes and kinds of sculpture.. page 826

FIG. 29. *Tegula* (*Chlorostoma*) *funebralis* (A. Adams), specimen No. 310 S. D. S. N. H., from locality 221, Cañada de Aliso, Ventura Co., middle Pliocene; altitude 32 mm. (in the position shown would measure 29 mm.), diameter 34 mm .... page 826

FIG. 30. *Tegula* (*Chlorostoma*) *gallina* (Forbes), specimen No. 311 S. D. S. N. H., from the middle Pliocene of locality 214, west of Fernando Pass, Los Angeles Co.; altitude 15 mm. This specimen is only about half grown. It is not as characteristic as the specimen shown in fig. 31... page 827

FIG. 31. *Tegula* (*Chlorostoma*) *gallina* (Forbes), specimen No. 312 S. D. S. N. H., from the lower Pliocene of locality 216, east of Fernando Pass, Los Angeles Co.; × 3, altitude 7 mm., diameter 10 mm. The color markings are unusually well preserved on this lower Pliocene fossil... page 827

FIG. 32. *Acmæa instabilis* (Gould), specimen No. 313 S. D. S. N. H., from locality 74, upper Pleistocene southwest of Goleta, Santa Barbara Co.; length 26 mm .... page 813

FIG. 33. *Capulus californicus* Dall, Recent specimen from San Diego, labeled 841A in the collection at Stanford University; greatest dimension 39 mm. As in *Acmæa* and *Lottia*, the interior is smooth, without deck or septum.. page 788

FIG. 34. *Crepidula onyx* Sowerby, specimen No. 214 S. D. S. N. H., from locality 221, Cañada de Aliso, Ventura Co., middle Pliocene; length 27 mm. This specimen and others which are quite common at this locality are indistinguishable from varieties of the Atlantic *fornicata* Linnæus, the type of the genus.. page 790

(*Continued on page 955*)

EXPLANATION OF PLATE 32—(Continued)

FIG. 35. *Terebra (Strioterebrum) albocincta* (Carpenter) variety *hindsii* (Carpenter), Recent specimen from Magdalena Bay, Lower California, labeled 744A in the collection at Stanford University; length 25 mm . . . . . . page 469

FIG. 36. *Lora pyramidalis* (Ström), Recent specimen from Griffin Bay, on the east side of San Juan Island, Puget Sound, San Juan Co., Washington, in 25 fathoms, labeled *L. rosea* Sars, No. 447A in the collection at Stanford University; length 23 mm . . . . . . page 528

FIG. 37. *Lora pyramidalis* (Ström), specimen from the same lot as that shown in fig. 36; length 21 mm . . page 528

FIG. 38. *Lora pyramidalis* (Ström), specimen from the same lot as the specimens shown in figs. 36 and 37; length 19 mm. These three figures illustrate the variability of this species. Most species of *Lora* are very variable, hence the many names and the difficulty of identifying specimens . . . . . . page 528

FIG. 39. *Lora viridula* (O. Fabricius), angular and many-ribbed variety, Recent specimen from San Juan Island, Puget Sound, labeled *L. fidicula* Gould, No. 433A in the collection at Stanford University; length 16 mm . . . . . . page 514

FIG. 40. *Lora viridula* (O. Fabricius), angular and fewer ribbed variety, from the same lot as the specimen shown in fig. 39; length 13.5 mm . . . . . . page 514

FIG. 41. *Lora viridula* (O. Fabricius), variety like that shown in fig. 40 and from the same lot; length 14.5 mm . . . . . . page 514

FIG. 42. *Lora turricula* (Montagu), Recent specimen from Puget Sound, labeled 448A in the collection at Stanford University; length 23 mm. This species is distinguished from *viridula* chiefly by size and number of ribs. It may be but a variety of it . . . . . . page 515

FIG. 43. *Lora turricula* (Montagu), specimen from the same lot as that shown in fig. 42, illustrating variation; length 18 mm . . . . . . page 515

FIG. 44. *Lora arctica* (A. Adams), reproduction of Sars' figure of "*Bela viridula* Möller," Moll. Reg. Arct. Norv., p. 235, pl. 16, fig. 7, 1878; × 3, length 12 mm . . . . . . page 533

FIG. 45. *Lora arctica* (A. Adams), reproduction of Sars' figure of "*Bela viridula* Möller, *juv.*," *op. cit.*, pl. 16, fig. 8; × 3, length 8.5 mm . . . . . . page 533

FIG. 46. *Nuculana* (or *Yoldia*) *astoriana* (Henderson) + *Nucula impressa* Conrad, 1849, not Sowerby, 1825, nor Hall, 1845, cotype, No. 3490 in the U. S. National Museum, from Astoria, Oregon, Miocene. Exterior of right valve, natural size. This specimen, being the best preserved of Conrad's cotypes, is hereby selected as the lectotype . . . . . . page 122

FIG. 47. *Nuculana* (or *Yoldia*) *astoriana* (Henderson) + *Nucula impressa* Conrad, cotypes, No. 3491 in the U. S. National Museum. Exterior impression, possibly of the specimen shown in fig. 46, and interior impression of the right valve of another specimen, the latter distorted in shape but showing the teeth; natural size . . . . . . page 122

FIG. 48. *Nuculana* (or *Yoldia*) *astoriana* (Henderson) + *Nucula impressa* Conrad, cotype, No. 3490 in the U. S. National Museum, from Astoria, Oregon, Miocene. Interior impression of another right valve, probably incomplete and distorted, natural size. This specimen may represent a different species . . . . . . page 122

FIG. 49. *Arca obispoana* Conrad, cotype, No. 13330 in the U. S. National Museum, from the Miocene of San Luis Obispo Valley. Exterior of right valve, natural size. As the other two cotypes are smaller and of the same valve, this one is selected as the lectotype. *A. obispoana* is related to *A. trilineata* (page 139) but is smaller and has less deeply sulcated ribs . . Not in text

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INDEX

All of the names and subjects are listed under a single alphabet. The principal passage is indicated by heavy type—**000**—, referring to the page on which the name or subject will usually be found in a heading. Systematic names of higher than generic rank are, however, not emphasized. Subordinate passages and ordinary mention are indicated by normal Roman type—000. Synonyms or names used incorrectly or in combinations not adopted in the present memoir are referred to in italics—*000*. Illustrations are indicated by plate and figure. Footnotes are referred to by the letter "n."—000n. If the "n." is separated from the page number by a comma—000, n.—, it signifies that the name or subject will be found somewhere else on the page, as well as in the footnote.

Specific and varietal names are not listed under the genera to which they have been assigned but will be found in their own alphabetical order. Under each species or variety are arranged the generic and subgeneric names and combinations to which that species or variety has been assigned, including both the names that have been adopted in this memoir and those that have been cited from other works. No attempt has been made to include all the combinations, but every generic and subgeneric name with which a specific or varietal name has been coupled in the text or synonymy should be represented in at least one of the combinations listed. *Species or varieties are cited as synonyms in connection with all combinations except those actually adopted in this memoir.* Hence, finding a name cited in the index as a synonym may mean that the species or variety is still valid and has merely been assigned to some other generic combination. With genera that have been divided into subgenera, the genus name listed alone in the index under a specific or varietal name stands for the typical subgenus. In such cases, a species or variety belonging to some other subgenus will appear, when listed after the genus name alone, as a synonym. On the other hand, with genera that have not been divided into subgenera in the text of this memoir, the accepted usage will be cited only under the genus name alone; and when sectional names appear in generic combinations as if they were subgenera, a species or variety will be cited after them as a synonym. However, in every case the accepted usage will be listed close by. In many cases species or varieties have been mentioned in the text colloquially under old, discarded generic combinations or appear only under such combinations in the synonymy. This is especially true of synonyms. In such cases the species or variety s cited under the old usage or usages as a synonym, and under the accepted combination the page is referred to in parentheses—(000), (*000*)—, even though the accepted combination may not be found in the place indicated. In some cases the accepted combination may be found only in the index. Occasionally, subjects and systematic names or combinations implied but not directly expressed are cited with the page number in parentheses. The appearance of a name or subject more than once on a page is usually noted only when the occurrences are so far apart that one or more of them might be overlooked by someone in haste.

A few abbreviations used in the text may require explanation:

C. A. S. = California Academy of Sciences; San Francisco, California.
L. S. J. U. = Leland Stanford Junior University; Stanford University, California.
S. D. S. N. H. = San Diego Society of Natural History; Balboa Park, San Diego, California.
U. C. = University of California; Berkeley, California.
U. S. G. S. = United States Geological Survey; Washington, D. C.
U. S. N. M. = United States National Museum; Washington, D. C.

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